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ABSTRACT

This handbook designed for secondary school use in exploring environmental problems and solutions and providing information on existent and emerging career opportunities, will be useful to school administrators, curriculum planners, instructors, counselors, librarians, and students. Developed by a 10-member project group, the handbook is in three parts: (1) Career Education and the Environment--an overview which sketches the extent of, reasons, and solutions for our present environmental degradation, (2) Environmental Careers--a comprehensive report divided into categories of science and research, technology and education, technology implementation, and equipment operation, and (3) two environmental education curriculums--a 15-day self-contained curriculum unit on environmental awareness and pollution tested in the Salt Lake School District, complete with an outline, lesson plans, student readings, and an exam, and a semester length course which focuses on the physical world, natural resources, and social problems with environmental overtones. An annotated 61-page bibliography supplements these curriculums, and is divided into eight categories for easier use as a selective guide for all schools wishing to start or upgrade their holdings in environmental literature. (CD)

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Career Education in the Environment

VT 015 386

Career Education in the Environment

A HANDBOOK

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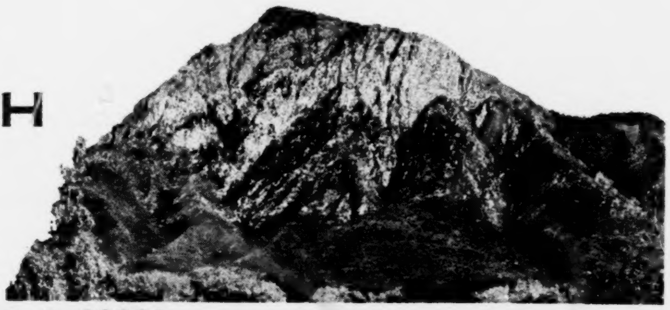

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PREFACE

This handbook is designed to be used in secondary schools to explore environmental problems and solutions and to provide information on existing and emerging career opportunities in this field. It is directed toward and intended to be used by school administrators, curriculum planners, life sciences and social sciences instructors, vocational counselors, librarians, and students. This handbook is divided into four distinct chapters:

(1) Career Education and the Environment. This chapter of the handbook sketches the nature and extent of environmental degradation; provides a view of the social, technical, and cultural reasons for this worldwide condition; and projects some specific and general solutions. The last points toward growing career opportunities in natural resource management, environmental planning, pollution control, and environmental health, and suggests some basic attitude changes necessary in our political, cultural, and economic habits.

(2) Environmental Careers. This chapter is a comprehensive report on the career possibilities in environmental occupations, centered around listings under the categories, Science and Research, Technology and Education, Technology Implementation, and Equipment Operation. Details include job descriptions of all occupations in this field; an analysis of the training or certification necessary to fill these occupations; a summary of the conditions, aptitude, earnings potential, and places of employment for each occupation; statistics and forecasts concerning the numbers, need, and type of positions; and finally, a listing of additional sources of information.

(3) Environmental Education Curriculum. This chapter contains two courses of environmental education. One is a three-week, self-contained unit focusing on environmental awareness and pollution. Complete lesson plans, a teacher's manual, and student readings are provided. The other is a semester-length course which provides breadth and depth to the study of the physical world, of natural resources, and of contemporary social problems having environmental overtones.

(4) Bibliography. This chapter includes annotated selections on both general and specialized environmental topics which are of particular interest to high school students and teachers.

Chapter 1

CAREER EDUCATION AND THE ENVIRONMENT

CAREER EDUCATION AND THE ENVIRONMENT

Man, particularly Western man, has always been callous in his treatment of the environment. As long as people were relatively few and scattered and technology was simple, the detrimental consequences of his actions were slight.

All of a sudden, during the last few years, events have reached a critical point, and environmental pollution has been forced into the consciousness of all but the most unperceptive. Smoke and smog, unsightly and poisoned streams, dying lakes, polluted oceans, ear-splitting noise, excessive use of pesticides, the threat of radiation--all of these threaten health and life itself. Deteriorating towns and cities, litter, the multiplying avalance of garbage and solid wastes, roadside lots filled with dead cars, traffic jams, crowds and congestion--these are not direct threats to life, but they certainly damage the quality of life.

As a consequence of long-term deterioration being suddenly brought to our consciousness, a few forecast the self-abolition of man. A more appropriate note was struck by President Nixon as he transmitted to Congress the first annual report of the Council of Environmental Quality:

> Our environmental problems are very serious, indeed urgent, but they do not justify either panic or hysteria. The problems are highly complex, and their resolution will require rational systematic approaches, hard work, and patience. There must be a national commitment and a rational commitment.

The environmental threats are indeed critical. But they were created by man and can be controlled and resolved by man. The pertinent questions are:

(1) What has caused them?

(2) What are the potential remedies?

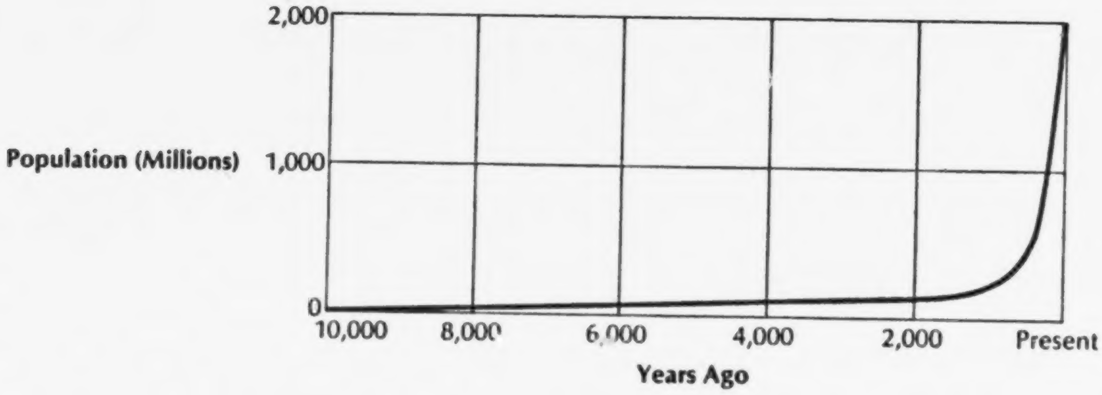
(3) Who will apply them?

This handbook has two goals: (1) to bring to the high school classroom an awareness of the threat of environmental deterioration to the quality and actuality of our lives, and (2) to identify the useful and rewarding careers which will significantly contribute to the fight against environmental problems.

WHY THE ENVIRONMENTAL CRISIS?

Environmental pollution has reached a critical stage as a result of complex circumstances, but five contributing factors stand out from among the rest: population growth, technology, consumerism, a misguided incentive system, and a pervading frontier psychology.

World population growth is following an accelerating trend which is frightening in its prospects. The following graph illustrates this growth:



Major factors in this trend have been the dramatic achievements in medical science and sanitation, with the resultant reduction in death rates in all nations. Much of the recent growth is due to the tenacity of old cultural patterns, which have birth rates persisting at their former pace in some of the poorest countries despite declining death rates. In most industrialized countries, on the other hand, the tendency has been for birth rates to decline as economic development and wealth increase. The populations of the "wealthy" countries are growing, but at a rate not nearly so great as that of the poorer nations. What the future will hold has been hotly debated. Some projections show decreased growth and increased abundance, while others foresee faster growth and disaster. Whatever the future holds, the present problem is apparent: It isn't so much that we have too many humans on earth as it is that we have too many in the wrong places. If we were better distributed over the earth's surface and were leading ecologically sound lives, we would not be faced with such severe and immediate environmental problems.

For the underdeveloped sections of the world, the issues are clear, even though the answers are difficult: the rate of births must somehow be brought into harmony with the increased life expectancy. Just how close to equality those two factors must be will depend upon the progress made in spreading the production of such amenities as adequate food, employment, housing, and health care.

Paradoxically, for the developed sections of the world, particularly the United States, the issues are less clear but the resources for their solution are readily at hand. It isn't that there are too many of spread over the vast landscape of our nation, but that we all insist on living too close together. The concentrated populations of the industrialized northeastern, southeastern, and western seacoasts, the Great Lakes ring, and the smaller interior complexes contrast with the wide open vistas obvious to every air traveler. Of course, not every open area will support a human population, but we are certainly not headed in the right direction by crowding large concentrations of people in sprawling urban areas. These population concentrations which press against our available ground space and our air, water, and other resource capacities are exacerbated by the way in which we choose to live in those concentrated places, our "life style." And that life style threatens even the environments of more scattered populations by disrupting the "ecology" of the natural world.

We can define "ecology" as the symbiosis among all living organisms, the interrelationships of living things with other living things and with their surroundings.

Casual observation shows that the technology or the techniques of production by which we multiply man's meager physical powers and produce the amenities and necessities of our relatively affluent lives has not been designed with ecology in mind. The factories which produce our gadgets belch smoke into the air or discharge industrial wastes into our streams. Often the products themselves--such things as plastics and aluminum cans--are environmentally destructive because they don't recycle themselves naturally; they just lie there. The rapid and often wasteful pace of production further depletes our natural resources. Energy, the life blood of modern society, is produced in ways which create smoke and various less visible air pollutants, which cause thermal pollution by emitting heated waters from power plants, and which exhaust the fossil and petroleum resources accumulated over billions of years. Our love affair with private transportation vehicles leads to air pollution, to the wholesale slaughter of thousands each year, and to a growing heap of solid waste when automobiles are discarded. The pesticides which reduce insect damage and make it possible for a few farmers to feed an immense population also pollute the soil and the bodies of living organisms, the effects persisting long after the offending insect pests have been dispatched.

In our great affluence and the resulting search for new luxuries, we further foul our nests on spaceship earth, the only home the human species has or likely will ever have available to it. Our luxurious automobiles are the major cause of air pollution, and their very production hurries the depletion of valuable minerals. The packages in which we purchase our consumer goods--from plastic bread wrappers to cardboard shipping cartons--are the source of the avalance of solid waste which threatens to bury us. Our demand for consumer goods requires increased output of electrical energy for the production of those goods. And our view that every family deserves its own suburban quarter-acre ranch is, in the opinion of most observers, a cultural source of wasteful land use.

These are just a few examples of our environmentally destructive consumer habits. Life is possible on a simpler scale, on a more rational scale. Are we willing to give up our pleasant gadgetry to make our lives ecologically sound? If not, can we find a way to have the products of our material culture and still make them and their use environmentally responsible?

Consumer habits are one part of the problem. What about the production incentive system which feeds upon those consumer habits? For example, throw-away products may seem inexpensive to the consumer, but they impose staggering costs to society--through clean-up costs, or by resulting in a shabby and unhealthy environment, or by using up our resources. In a similar way, tax depletion allowances for forest, fuel, and mineral goods actually quicken the development and consumption of our limited reserves. These examples, drawn from myriads of others, indicate the inadequacies of the incentive system of the private marketplace. The competitive marketplace has historically provided positive incentives for rapid economic development; the greatest rewards went to those who could most aggressively exploit opportunities. That incentive system has proven its ability to get what the consumer wants produced in mass at relatively low prices. But we have not included the total costs of production, particularly those costs related to the environment. Our failure to include total costs has encouraged greater consumption than would likely have occurred if the consumer had been required to pay the full actual cost in his purchase price. Suppose we found a way to include the environmental cost in the price of our consumer products--by the penalties of taxation, by requiring effluent or emission fees, or by instituting direct controls. Both the producer and the consumer could then be forced into a full recognition of their impacts upon the environment. Incentives to pollute could easily be replaced by incentives to ecological conduct.

One reason we have so long ignored the inverse incentive built into our marketplace transactions has been the tendency to think of many of our vital natural resources as abundant and costless. We call this a "frontier psychology." Early settlers burned off the forests, abused the land until its fertility was exhausted, and then moved on to open new land the in turn abuse it. The early lumber industry cut down the forests as if the supply of timber were endless. Mineral resources were mined and oil wells were dug in the same spirit. By the turn of the century, the disappearance of the open frontier was a recognized fact and the conservation movement emerged.

But the frontier psychology did not die. We still view clean air and pure water as if they, too, are endless. But there is only so much of each in or around spaceship earth; we will never have more. The "frontier" which now needs "conquering" is no longer open space, but human nature.

Our cavalier use of the land we have is a case in point. We want the convenience of a city's amenities, yet genetically and biologically, man is not a city-dwelling animal. Psychologists tell us that crowding markedly affects our behavior, and one authority has called the American city an anti-city. Generally speaking, the only persons who live in large cities are the poor and the very rich, those who can't afford to move out and those who can afford to import non-city amenities into plush urban apartments. The rest of us, as rapidly as we can, seek vicariously to emulate the two or three "cowboy decades" at the close of the frontier period. Everyone wants his own homestead or ranch, even if he can afford only a postage-stamp lawn surrounding a crackerbox house among identical thousands of crackerbox houses in a typical suburb. The private costs of this life style may not be unduly high, but the social costs in terms of land use, transportation waste, central city deterioration, and aesthetic affront are excessive.

Man's developmental urge, which was so effective in transforming an underdeveloped continent with a scattered handful of inhabitants at the mercy of the elements into our modern, complex society must be channeled into new directions.

The old frontier is gone; resources are limited. The new frontier is the challenge of learning to live abundantly and cooperatively amid obvious scarcity.

POTENTIAL REMEDIES TO ENVIRONMENTAL PROBLEMS

Learning to live "ecologically sound" lives will require substantial changes in our life styles, even while we are searching for and implementing remedies to our existing environmental crises. Each remedy or solution proposed, whether aimed at curing a single abuse or a whole spectrum of abuses, should take into consideration the full range of its future environmental implications. Each solution should be geared not only to correct an obvious abuse, but also to eliminate the root cause of that abuse and to guard against creating new long-range problems.

Each prescriptive cure for an environmental illness should include long-range goals which consider the judicious management of what resources we presently have, the conservation of their use, the recycling of any used portions, and the repair of any severe damage to the planetary mantle. That will require each of us to know more about our environment than we have known in the past, and it will require more of us to devote our vocational and avocational energies to environmental concerns than has traditionally been the case.

Perhaps the most critical and pressing problems of all concern our burgeoning population: over three-and-one-half billion persons currently inhabit our spaceship, the vast majority of whom are leading lives of poverty. Collectively as a nation, and individually, as world citizens, we must closely examine our beliefs concerning human reproduction and distribution. We need to know much more about the human cargo-carrying capacity of our planet, about how many of us it can support, about what kinds of support it can reasonably provide, and about how we can most intelligently distribute ourselves in terms of location, age, and objectives.

Some maintain that it may be necessary for all the world's citizens to reach some conscious agreement regarding life styles, family size, and basic human needs if the earth is to continue supporting life as we know it today. Such a step would, of course, require advanced methods of population control in all countries whose food producing capabilities are insufficient to supply the needs of its population, or whose culture and life habits are severely damaging to their natural environment. To make such decisions will require the study and development of population distribution policies and practices harmonious with the ability of land, air, and water resources to sustain high concentrations of people. In many cases it may require masses of people to either radically change their life style to make it more ecologically sound, or to reduce their birth rates to encourage the stabilization of population numbers, or to physically rearrange themselves into areas which are capable of supporting a particular population. In any case, it will undoubtedly require a considerable number of well-trained individuals--ranging from urban planners to demographers to health officials--to plan, direct, and operate any changes in population distribution or life style.

Even if the population problems are solved, we must still deal with the environmental damage which has already occurred and take steps to guard against future damage. This will involve scientific research leading to technological advances. These advances will be directed toward eliminating environmentally destructive practices and should lead to safer and saner tools, devices, methods, and procedures. For example, the development of short-lived pesticides, the implementation of natural biological controls, and the use of radiation sterilization on insects could very likely replace the use of hard pesticides such as DDT. Tertiary waste water treatment facilities and effective electrostatic precipitators can be developed and used more extensively to help protect the natural environment. All these efforts to develop and build technological innovations designed to improve environmental quality will require many scientists, engineers, technicians, and operators.

Another remedy which has been discussed to help solve our environmental problems is to change consumer habits, especially in America. The greatest contribution an individual can make in redirecting his purchasing habits is simply to economize his wants and purchases. By not buying products which are excessively packaged, products of short durability or poor quality, and products which are simply unnecessary convenience items, a consumer can help eliminate solid waste. And until the day arrives when pollution-free automobiles are available, we can help reduce pollution by supporting mass transit systems, by joining car pools, and by rediscovering the joys of walking and riding bicycles on short trips. Individually, we can also help by supporting laws which provide for strict zoning regulations and land-use policies to help eliminate disorderly land development which threatens to destroy all the available land in the United States. The development of a new consumer ethic will require the individual effort of each of us, but it will also require the help of sociologists, psychologists, and political scientists who understand human behavior and the factors which influence it.

In the economic area, major changes may be necessary to create economical and environmental balance. Our present values of material wealth and success through economic gain may well be replaced by values which deal more adequately with simple survival, cultural development, and non-material consumption. In the future, products and services should more nearly reflect the total costs involved in providing them, and these costs will invariably be higher than at present. Hopefully, one benefit of this total cost approach will be to drive out business or force off the marketplace any firm or product whose environmental price tag is too high. Another benefit will be to rid the market of superfluous gadgets and convenience products. Examples of products and processes in urgent need of change include automobiles, electrical power generating plants, strip mining, excessive overgrazing of grasslands, and the large national expenditures on military hardware.

There are many methods which can be used to create a more sound environmental economy. They include: special tax benefits to reward environmentally acceptable behavior and products; tax penalites and fines which punish polluters; research, construction, and operation grants for such processes as waste water treatment; the development of better transportation systems; and a more realistic pricing system for products obtained from natural resources in short supply.

Sociological, technological, and economic solutions mentioned above will be of little value unless we can deal effectively with individual behavior patterns and eliminate our "frontier psychology." This can best be achieved through the many avenues of education, from the public school system to the mass media. Formal education must lead the way. We should update the curricula of schools to include an understanding of the natural systems of the universe, an appreciation of man's unique place in that universe, and a respect for man's finer accomplishments in life. Education must provide concepts of both "how to live" (environmental education) and "how to get a living" (career education). These two goals are inherently compatible. This educational approach should attempt to provide the citizenry with proper environmental standards and should try to influence people to live their lives and treat the spaceship earth in a dignified manner. Most important of all is the need for education to reinstill in humans the desire to work for environmental improvement and the confidence that man can indeed resolve the problems he has created for himself. In this overall educational effort the teacher, the parent, and the communications specialist will play important roles.

One last remedy is an inherent part of all the other remedies at the same time that it supports those remedies. An informed and concerned citizenry will promote and support strong environmental legislation, including stronger and more wide-reaching laws regulating the development of all natural resources and preventing the careless disposal of unconsumed or recyclable wastes. Such statutes should provide for injunctions against wasteful operations and stiff penalties for all violators. They should be accompanied by strong enforcement procedures. This increase in legal activity will require more attorneys trained to deal with the whole range of environmental law, as well as trained enforcement personnel.

Each of these remedies is an ambitious undertaking, but nothing less is needed to solve our numerous environmental problems. There is no reason to doubt man's ability to solve the problems he has created; neither is there reason to question his capacity to redirect his own energies toward those solutions. However, first must come a well-informed citizenry, and educators must assume responsibility in that area if satisfactory progress is to be made.

THE ROLE OF ENVIRONMENTAL EDUCATION

Beyond the provision of basic skills, the primary objective of education has always been to inculcate within the individual an understanding of his society and of his place within it, and to aid him to function successfully within that environment. In that sense, education has been a conservative influence. But it has also accepted the role of providing analytical skills which, when applied, have been instrumental in identifying shortcomings in the status quo and in encouraging progressive reforms.

The environmental crisis now confronts education with a new challenge. It must produce citizens who are not only environmentally aware but who have values which are compatible with ecologically sound living. Historically, education indoctrinated generations with the values which have led to our present condition.

Most of those values were desirable, and their results have been positive in most applications. However, for those values which were not favorable or will not be favorable in the future to man's continued existence on spaceship earth, new concepts and new techniques must be substituted. All formal and informal education must be blended together to produce an environmentally aware generation.

Many young persons have already been excited by the environmental challenge, but they have not always known what to do to be most effective. More are probably still untouched by the issue. Education's response in this field must be not only to consider the problems and their possible solutions, but to deal with the whole question of who will perform the various tasks involved. Of course, this means increased concern for vocational guidance and career education, particularly in the environmental area.

In order to accomplish these goals, teachers in all subject areas must emphasize environmental implications. For instance, biology classes must view man as one living organism, interdependent and interacting with all other organisms in a mutually beneficial relationship--the most important organism, perhaps, but still only one of many. Economics classes must consider as part of their theoretical study the unseen social costs of private economic activity, and they must provide the analytical tools for appropriate policy decisions. History classes must view the environmental mistakes of the past, as well as the accomplishments. English and communications classes can utilize material dealing with the environment, both in literature and in writing assignments. Art, music, and drama are important in promoting self-realization and in establishing a respect for the ideas of others. Indeed, no subject matter is irrelevant: all can contribute to environmental awareness without "watering down" the traditional course content in any way. Environmental content will likely make classes more relevant and more interesting to the students. And in addition to including environmental considerations in traditional courses, it will also be necessary to create entirely new classes, such as "Pollution Problems," "Environmental Ethics," or "Natural Resource Study."

Environmental pollution and the depletion of natural resources can be effectively illustrated with startling statistics and a growing bibliography of literature, but first-hand experience is usually more motivating than abstract discussion. No subject matter is better adapted to learning through experience than that dealing with the environment and ecology. Pollution can be seen and felt and smelled and heard; resource depletion can be similarly observed. Environmental education should get outside the classroom and into the environment. It should involve students not only in the theoretical identification and analysis of problems but in practical understanding and solution of them.

This concept of environmental education should not be disconcerting to members of the educational establishment. Education has always adapted to new methods, to new academic disciplines, and to new emphases. Its ability to adapt is a reflection of man's own adaptability. At one time man adapted to his environment because he had no choice. Then he found he could change his environment, and he arrogantly sought to remake it in his own image. Now he recognizes that effort as a mistaken one, and he must learn to live in harmonious relationship with the best of his environment. But he wants to do so without foregoing the tools that have allowed him to ameliorate the harshness of nature and to free himself from enslavement to bare subsistence needs. Education, too, can and must adapt to the needs of the society it serves.

THE CONTRIBUTIONS OF CAREER EDUCATION

The development of an environmentally aware generation will have a major impact upon the policies and the policy-making process of a democratic society. Citizens who know their long-run best interests are most likely to promote them through all the means at hand. Being aware is only the beginning. When society perceives a need and sets objectives, it then moves to allocate its available resources to the priorities indicated by the objectives.

As every elementary economics student knows, the basic resources of the society are natural resources, capital resources, and human resources. In an earlier age, natural resources determined a society's wealth and welfare, especially the fertility of its soil. Subsequently, though natural resources never lost their importance, capital resources--the technology to expand man's productivity--rose to preeminence. Now we appear to be entering an age when human resources will dominate. It is a time when the most critical problems of society do not lend themselves to attack based on land, new materials, or machines. The primary tools of this society are the talents and skills of its people. Whatever its problems--the search for peace, the abolition of poverty, the prevention and cure of disease, the reduction of crime, or the control of environmental quality--the solutions depend upon dedicated, talented, and well-trained people who understand and can intelligently use whatever technological tools are available.

It is growing awareness of this new dependency that has pushed the U.S. economy into an educational investment which has expanded from $6 billion to $65 billion in 25 years. It is the same phenomenon which underlies the emergence of remedial manpower programs to assist those unable to compete successfully in more sophisticated labor markets. It is this same awareness which has fostered the new concept of career education.

Career education, now the first priority of the U.S. Office of Education, is unusually compatible with the concepts of environmental education endorsed above. It emphasizes from among education's multitudinous objectives the preparation for and pursuit of a career. It is not another name for vocational education or for academic education, but it integrates both. Its fundamental premise is that every teacher in every class can and should emphasize the career implications of the subject matter. It asserts that such reality consciousness can aid both student and teacher, demonstrating relevance to the student and providing a constant measure of achievement for the teacher. Like environmental education, it merges theory and "hands-on" experience. It provides bridges between the worlds of the home, the school, and work. Its concerns are all of those attributes which make for career success: good mental and physical health, human relations skills, commitment to work as the appropriate source of income, basic skills of communication and computation, appreciation of historical and modern culture, exposure to the full range of occupational opportunities and to their educational requirements, and acquisition of sufficient job skills to be able to function in the labor market. Yet, career education is not limited to the school and to the school years. It integrates and coordinates learning experiences and holds open the door to a lifelong process of job entry and exit as interests and needs change.

The educational goal of preparing citizens for successful careers complements the goal of instilling environmental awareness. Both share similar objectives, such as citizenship, family life, and culture. Environmental education can spread a general awareness of the environmental crisis. It can encourage individuals to conduct their lives in a more ecologically sound manner. Career education encourages early and continuous thought to alternative career choices. In a world where goods-producing occupations are of declining importance, it seeks to replace the traditional work ethic with a service ethic. Among those careers to be considered are included a wide range of opportunities in environmental management, careers which offer the satisfaction of providing significant services to society.

As a result of these two programs, all citizens will hopefully be motivated to an environmental awareness and to a change in life styles. A few will be motivated to dedicate their working lives to that worthy cause.

CAREERS IN ENVIRONMENTAL MANAGEMENT

The second of this handbook's two objectives is to explore the advantages and prospects for careers in environmental management occupations. Every occupation has some type of environmental aspect. Some occupations, such as those of chemists and botanists, are directly involved in environmental affairs. Others, such as those of businessmen, secretaries, and housewives are indirectly involved. As society becomes aware of the challenge and attempts to clean up its pollution and conserve its resources, well-trained minds and competent hands will be required across the full range of skills--semi-skilled laborer, operator, craftsman, paraprofessional, technician, and professional.

Before workers can be attracted to these occupations, they must have knowledge of their existent, of the prospects for expansion, of the educational, training, and skill requirements, of the pay and working conditions, and of the prospects for upward mobility. No one wants to propagandize a youth or bias decisions by inadequate or inaccurate information. The goal is to provide realistic information and to aid the teachers and counselor whose job it is to pass it on to the student in forms which assist without interfering with his freedom of choice. It is his life, and his career must be his choice. But that choice must be a realistic one based on the best information available.

Some environmental management occupations are old and familiar, such as park ranger or oceanographer. Most are new. Some, such as ambient air analyst or recycling technician, are only emerging, and many will yet emerge as society takes the environmental challenge more seriously. Most current opportunities are identifiable. The future is always opaque, but since decisions about the future must be made, they are best made by employing reliable information. Foreseeing the future is a matter of projection. Current trends are extended, but they are modified as ways are identified in which the future will likely differ from the past.

Here, then, in this handbook and in the audiovisual materials which accompany it are some of the initial materials a secondary school teacher or counselor might use to:

(1) become environmentally aware;

(2) transmit that awareness to students;

(3) illustrate for all students the opportunities, advantages, and disadvantages of careers chosen from among environmental fields; and

(4) provide more specific guidance for those with sufficient interest to seek further information leading to possible careers dedicated to a cause involving life's continuance and its quality.

Chapter 2

ENVIRONMENTAL CAREERS

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INTRODUCTION

Chapter two, a comprehensive report on the career possibilities in environmental areas, is designed to be used primarily by secondary school vocational counselors and by individual students working independently. Included in this chapter are job descriptions, training requirements, salary ranges, occupational aptitudes, and conditions for employment for each career listed under the headings of science and research, education and technology, technology and implementation, and operation and application. Additional information includes selected statistics on present employment numbers and forecasted needs as well as other sources of information and data pertinent to environmental careers.

It is hoped that the information will arouse genuine interest and commitment of students and counselors in the promotion of occupations which have great significance toward maintaining a healthy and safe natural environment.

I. ENVIRONMENTAL CAREERS

ORGANIZATION AND SELECTION FOR ENVIRONMENTAL CAREERS

The most urgent challenge facing mankind today is the battle to save our environment. Our waters are fouled. The very air we breathe is in serious peril. The combat has begun, and a speedy persuit toward our goal is essential.

Rapidly growing public concern over environmental quality has resulted in a dramatic interest in the manpower needed to develop, plan, and implement prevention and control activities. Although mass public concern is relatively recent, the basic mechanisms and technology have been developing for many years. Begun largely by the concern and efforts of health officers and sanitary engineers in providing safe supplies of drinking water, milk, and foods and by numerous natural resource and wildlife conservationists, the fields of action and the variety of professionals and technicians involved have expanded into a broad-scale view of protecting and restoring the quality of modern environment.

Environmental protection and control efforts represent a diverse area of work and consequently draw heavily on a wide variety of occupations. Virtually every occupation can be related to some aspect of environmental pollution control and resource conservation. The extensive nature of environmental pollutants, i.e., air, water, noise, etc., and the need to convert solid waste into useful resources permit contributions by a wide spectrum of occupational groups. However, to determine and assess the manpower requirements of specific occupations related to the above groups requires setting limits on occupational categories that specifically engage these problems on a conscientious, continuous basis.

There are many supporting occupations that can play an important role, i.e., secretarial, stenographic, data processing, etc., but they are generally non-specialized and can be obtained without specific training programs. Likewise, many managerial and administrative posts, regardless of their relationship to the natural or cultural environment, have been omitted from this handbook.

There has been relatively little effort to assess the environmentally related manpower situation in depth and over a period of time. Deterrents to the development of such information include a lack of understanding or definition of the various professional, paraprofessional, and supportive occupational roles and functions, and the need for occupational interpretation in terms of categorized disciplines and program specialization. Much additional effort is necessary to identify and measure factors of supply, demand, utilization, and production of environmental manpower.

However, it is apparent that the complex problems facing us cannot be handled without a sufficient number of technically and scientifically trained technicians, engineers, and scientists. It is essential that we be aware of what environmental deterioration and pollution are, their causes, and the recreational, economic, and physical and mental health losses resulting from pollution. In addition, we must become knowledgeable in the various methods of controlling pollution and the high but unavoidable cost of reversing the trend toward environmental destruction.

In this age of strong emphasis on education, students are bombarded with statements about the need for trained persons in various fields. In this environmental field the need is desperate because present manpower and knowledge are insufficient to deal with this enormous task.

This chapter on environmental careers is designed for students who want to do something to help save the environment and for counselors and teachers who want to assist in their endeavors.

The subsequent list of occupational descriptions is not intended to be comprehensive for all conceivable occupations related to the identification, analysis, or solution of environmental problems because virtually every vocation can produce conditions with environmental overtones. However, it was decided that a more useful document could be produced wherein a selected list of occupations is shown, based on functional characteristics. Thus only those occupations that demonstrate a functional relationship to the identification, study, or solution of environmental problems have been included. Also, only occupations that are directly involved in environmental areas are described.

Some aspects of the listed occupations have been omitted or only a cursory discussion has been provided. A reasonably exhaustive search of occupational literature has been made in preparation of this handbook. Where wage, employment, or training data were notavailable or where they appeared to be of questionable accuracy, they were not included in the description.

To present information on career paths and occupations in this handbook, four main career "clusters" have been developed; an outline of these is provided below.

1. Careers in environmental science and research:
   a. Life scientists
   b. Physical scientists
   c. Social and behavioral scientists.

2. Careers in environmental technology and education:
    a. Environmental educators
    b. Environmental engineers
    c. Environmental health services
    d. Environmental planners
    e. Natural resource managers.

3. Careers in environmental technology implementation:
    a. Environmental technicians
    b. Environmental inspectors and monitors
    c. Environmental testors and analysts.

4. Careers in environmental equipment operation:
    a. Operators
    b. Attendants and support personnel.

Although there are many other ways in which occupations can be classified, the above categorization best meets the need to minimize redundancy. Occupations are clustered by similar educational requirements and by nature of work.

At the beginning of each major occupational category, a general description is provided concerning the broad overview of the relationship of those jobs to the environment, to the education and training required, and where available, to the wage information based on 1968 data. Because of inflation, most occupations have salary structures higher than that which is presented. No attempt has been made to update these figures inasmuch as no reliable factor could be found which would accurately apply to all of the occupations presented in the handbook. Particular information relating to specific occupations provided in the actual job description is as current as possible.

In an emerging "new career" area, hard data on the present supply and future demand are difficult if not impossible to obtain. In most cases, it is known only that certain career paths are open and will require significant numbers of new entrants. Environmental careers are no exception. Extensive research of existing data sources, contact with professional organizations, and direct contact with appropriate governmental agencies have shown that virtually no data exists on the current supply of environmental manpower, and even less is known about future needs. Therefore, one of the major tasks of this handbook is to examine career paths, determine the level of expected or authorized legislative appropriations, and estimate for 1970 to 1975. Our projections are related to six areas of environmental control: air, water, noise, solid waste, pesticides, and radiation. (These are areas identified by the federal government, and indeed are not all-inclusive.)

Thinking of careers in terms of environmental occupations is just now beginning. There have been employees working in sewage disposal plants and water works for decades, but only in recent years has there been a conscious realization that these occupations and numerous others constitute an effort to provide mechanisms to help ensure an unpolluted environment. There has also been a realization that mankind must make a conscientious effort to conserve the earth's natural resources. Resource conservation and the attack on pollution have been many faceted. Air, water, and solid waste are the most generally recognized sources of pollution, but noise, pesticides, radiation, etc., also constitute sources of pollution that must be studied.

This handbook will fulfill its basic goal only if it is used. It will be used if it is helpful in career counseling and if it provides the necessary information in an easily accessible manner. There are several standard sources of occupational information, most significantly: Dictionary of Occupational Titles (DOT), Occupational Outlook Handbook (OOH), and Modern Vocational Trends Reference Handbook.[1] Each of these sources attempts to analyze and consolidate information on certain types or categories of occupations. DOT is the most comprehensive, while OOH is most frequently used. DOT gives brief job descriptions based on a standardized format of work or data elements. OOH has six categories of information and approximately 700 occupations covering the entire occupational spectrum. The information elements are: (1) nature of work; (2) places of employment; (3) training, other qualifications, and advancement; (4) employment outlook; (5) earnings and working conditions; and (6) sources of additional information (which is primarily in narrative form with some pictures depicting various aspects of the particular occupation).

The third-mentioned handbook attempts to provide general vocational guidance by presenting various aspects of the most frequently entered careers and is more detailed than OOH for it includes 12 informational elements for each occupation. They are: (1) duties and practices; (2) aptitudes, interests, and other characteristics: (3) major fields of employment; (4) physical activity and working conditions; (5) women in the field; (6) where employment is found; (7) possibilities for advancement; (8) education, needed and related; (9) licensing; (10) remuneration; (11) advantages and disadvantages; and (12) professional sources of information.

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[1] Bureau of Employment Security, U.S. Depart of Labor, Dictionary of Occupational Titles, 1965, 3d ed.; Bureau of Labor Statistics, U.S. Department of Labor, Occupational Outlook Handbook, 1970-71 ed., Bulletin no. 1650, and Modern Vocation Trends Bureau, Modern Vocational Trends Reference Handbook, 7th ed.

Two other reference books are useful; one[2] provides relatively detailed information on 20 technician occupations related to the environment and the other[3] gives extensive information concerning more than 200 health-related occupations. Numerous other pamphlets, bulletins, and articles were used by the research staff in compiling this handbook but are not documented herein.

OUTLOOK FOR ENVIRONMENTAL CAREERS

In this handbook, occupations shown as being environmentally related represent an attempt to be relatively inclusive but not exhaustive. Only those occupations that were considered to have a substantial connection with environmental protection, correction, or education have been presented.

The nature and dimensions of what could be classified as an environmental problem or concern are just now being extensively examined. The physical and biological aspect of the world's problems are being expanded to other concerns, such as visual pollution, cultural change, and social deterioration. Such definitions as these are not included in this chapter although they are thoroughly presented in other portions of this handbook. The environmental problem areas for which occupational data were collected were limited to physical, biological, and to some extent, educational. categories. Such areas of work include prevention and control programs.

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[2] Walter M. Arnold, Career Opportunities: Ecology, Conservation, and Environmental Control (Chicago, Ill,: Doubleday Ferguson Publishing Co., 1971)

[3] Bureau of Employment Security, U.S. Department of Labor, Health Careers Guidebook.

environmental facilities and equipment design and operation, research and development work, planning, surveillance, enforcement, etc.

It is a fairly simple task to classify an occupation as being related to environmental work compared to the task of obtaining relevant estimates or projections of employment. But problems exist in classifying occupational titles where several jobs may have essentially the same duties and functions but are known by several names, which also complicates the task of estimating. Furthermore, viewing occupations as being environmentally related is very new, and job information is not yet available. Although the Bureau of Labor Statistics (BLS) has done extensive work in identifying and projecting occupational manpower requirements, the 230 jobs presented in a recent BLS report do not provide any clear identification or classification for environmental workers.[4] Those occupations represent only 50 percent of all professional and technical workers, 99 percent of salesworkers 81 percent of craftsmen, and 65 percent of clerical workers. Such occupational data have been developed by BLS primarily to aid officials concerned with future planning for education and training needs.

Estimates and projections of future occupational needs can be useful, but they must be treated with care. Recent flurries of estimates and projections of environmental manpower needs are "popping up" in many current articles in journals and publications. They seldom match one another and, in some cases, are not too helpful in describing how the authors arrived at their occupational classifications or methods of projecting or estimating. Consequently, these articles must be viewed with some reservations at the present time.

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[4] Bureau of Labor Statistics, U.S. Department of Labor, Occupational Manpower and Training Needs, 1971, Bulletin no. 1701.

All projections or estimates are only as good as the data and methodology used to create them. Techniques for projecting are usually based upon: (1) extrapolating past events into the future, (2) defining causal relationships and what they will be in the future, (3) tinkering with trend lines (or matrix determinants) by adding judgment or insight factors such as technological changes, or (4) some feeling for change in how government might allocate its resources. In the real world of making projections, the lack of sufficient and precise data continually plagues those making them, and confidence in such estimates can vary widely. Such is the current plight of data on environmental occupations.

However, projections can be useful if their limitations are understood. In order to obtain some estimate of the number of environmentally related jobs for the purposes of this chapter, two basic approaches were used. The first was to use occupational information prepared by BLS[5]. Table 2-1 presents a list of those occupational titles that could be readily identified or inferred to be close to those occupations shown in this chapter as being environmentally related. Some care should be used in interpreting the table. For example, the 1970 estimated job requirements (e.g., for biochemists) of 12,000 is based on the 1968 employment estimate made by BLS and adjusted for two years by the average annual employment openings of 500. The 1975 estimate is adjusted by five times that annual figure to arrive at the 14,500. Also, the occupational estimates presented are for the total jobs that are under a given title and not just those that could be considered as dealing with environmental problems. Take for an example the occupation of chemist--not all chemists are directly working on environmental problems; some are engaged in industrial processes, chemical products development and refinements, and the like. Others may be working on biodegradable

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[5] Ibid., pp. 67-74.

Table 2-1
ESTIMATED JOB REQUIREMENTS FOR SELECTED OCCUPATIONS
1970-1975[a]

Classification	1970 Estimated Job Requirements	1975 Estimated Job Requirements	Percent Change 1970-75	Average Annual Openings	Estimated Replacement Needs[b]
Science and Research					
Life Sciences					
Life Scientists	181,600	210,600	16.0	5,800	9,400
Biochemists	12,000	14,500	20.8	500	200
Physical Sciences					
Astronomers	1,500	1,750	16.7	50	50
Chemists	142,000	172,000	21.1	6,000	6,800
Geologists	23,600	25,600	8.5	400	400
Geophysicists	7,100	7,850	10.5	150	150
Oceanographers	6,000	8,000	33.3	400	100
Meteorologists	4,200	4,700	11.9	100	100
Physicists	49,800	61,800	24.1	2,400	2,200
Social					
Anthropologists	3,200	3,700	15.6	100	100
Economists	33,800	40,800	20.7	1,400	800
Geographers	4,100	4,600	12.2	100	100
Political Scientists	12,300	14,550	18.3	450	350
Mathematicians	72,000	89,500	24.3	3,500	4,900
Sociologists	10,600	12,100	14.1	300	300
Statisticians	24,800	29,300	34.4	900	700
Education and Technology					
Engineers					
Aerospace	66,800	71,300	6.7	900	500
Agricultural	12,400	13,400	8.1	200	200

Table 2-1 cont.

Classification	1970 Estimated Job Requirements	1975 Estimated Job Requirements	Percent Change 1970-75	Average Annual Openings	Estimated Replacement Needs[b]
Chemical	52,200	57,700	10.5	1,100	500
Civil	194,800	231,800	19.0	7,400	4,100
Industrial	131,000	158,500	21.0	5,500	1,700
Mechanical	225,400	251,400	11.5	5,200	3,400
Mining	5,050	5,175	2.5	25	75
Electrical	249,000	296,500	19.1	9,500	3,000
Health					
Dieticians	32,000	37,000	15.6	1,000	1,700
Physicians	321,000	386,000	20.2	13,000	7,000
Sanitarians	10,600	12,100	14.1	300	300
Natural Resource Managers					
Foresters	26,200	29,200	11.4	600	400
Forestry Aides	14,200	17,200	21.1	600	300
Range Managers	4,200	4,700	11.9	100	100
Planners					
Architects	36,600	43,100	17.8	1,300	1,000
Landscape Architects	9,000	10,250	13.9	250	250
Urban Planners	8,200	11,200	36.6	600	200
Technology and Implementation					
Technicians					
Engineering and Science	664,000	774,000	16.6	22,000	9,000
Instrument Repairmen	90,800	105,300	16.0	2,900	1,700
Equipment Operation					
Inspectors--Manufacturing	593,400	614,400	3.5	4,200	15,000

Table 2-1 cont.

Classification	1970 Estimated Job Requirements	1975 Estimated Job Requirements	Percent Change 1970-75	Average Annual Openings	Estimated Replacement Needs[b]
Stationary Engineers	262,500	268,750	2.4	1,250	5,800
Waste Water Treatment Plant Operators	26,300	33,300	26.6	1,400	1,100

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[a] Based on projections made in Occupational Manpower and Training Needs, Bulletin 1701, U.S. Department of Labor, Bureau of Labor Statistics, 1971. BLS estimated employment in 1968 was adjusted by the average annual openings 1968 to 1980 to obtain 1970 and 1975 estimated requirements.

[b] Estimated replacement needs are not reflected in the estimated job requirements. This information is provided only to give some idea of the number of workers who will be required for replacement of those who retire, die, terminate, etc.

materials or the reduction of hazardous chemical pollutant discharges or wastes. Therefore, in Table 2-1, the estimated jobs are not exclusively those that are concerned or directly work with environmental problems.

Fairly good definitions of occupations were available in the categories of environmental science and research and of education and technology as used in this chapter. However, very limited data were available for occupations in the technology implementation and equipment operation categories.

It appears that estimated job requirements for the occupations listed in Table 2-1 in the first major category, science and research, will grow from a range of approximately 8.5 percent for geologists to 34.4 percent for statisticians between 1970 and 1975. The number of average annual job openings also varies from a low of 50 for astronomers to a high of 6,000 for chemists. However, the estimated replacement needs for each year in some cases exceed the estimated growth in job requirements, such as in the cases of life scientists, chemists, and mathematicians. Replacement needs are caused by such changes as termination, change of jobs, withdrawing from the labor force, death, retirement, etc. Consequently, the number of job opportunities, estimated from BLS data on an annual basis, can be a significant factor in overall job opportunities in any given occupation.

In the second major category, no precise data were available for those engaged in environmental education. For those occupations listed under the category of technology and education in Table 2-1, a range of estimated changes is shown between 1970 and 1975. For example, on the low side, new jobs for mining engineers are estimated to grow by 2.5 percent, and by 36.6 percent on the high side for urban planners.

In the third and fourth major categories, the lack of occupational data permits little to be said of what might be anticipated except for a few job titles. From the minimal data that are available, it is estimated that technician jobs related to science and engineering will grow from 664,000 in 1970 to approximately 774,000 by 1975, or a 16.6 percent change. Annual job opportunities will probably be about 31,000 (annual openings plus replacement). Such occupational information is presented only to give some idea by specific job classifications of what might be anticipated between 1970 and 1975. (This was based on BLS data and not adjusted or reduced to include only those jobs that could be considered to be environmentally related.)

Given such problems, another approach to estimating environmental manpower requirements has been developed in this chapter. Most of what will happen with environmental protection or problem correction will largely involve public pressures being brought to bear in making it illegal to pollute. Thus the creation of legislation will be extremely important in what happens, for both the public and private sectors of the economy. Making laws, however, is not enough; it also takes money and people to enforce the law. Consequently, when estimates are made of environmentally related jobs as presented in this chapter, it is assumed that there are three major determinants for such jobs: legislation, budgets, and enforcement.

A second approach essentially involved developing some idea of the amount of money to be spent on environmental pollution problems and then translating such expenditures into manpower requirements. For those who are interested in a statement of methodology regarding this approach, a technical discussion is provided in Appendix 2-3. Obtaining adequate information on the amount of money to be spent in cleaning up the environment is difficult. The most comprehensive data on such expenditures were provided in a recent report by the Council on Environmental Quality.[6] As indicated in the Council's report, if environmental standards are met on schedule, the total annual costs of pollution control will almost double between 1970 and 1975, or an increase of 97 percent. Within this overall gain, however, the costs for air pollution are expected to jump by 840 percent, which means very little was being done in 1970. However, by 1975 expenditures will increase significantly. Costs for water pollution will grow by 87 percent, and by 37 percent for solid waste management. Similar estimates for noise, radiation, and pesticide pollution, however, were not available. In terms of dollars, about one percent, $9.6 billion of the 1970 gross national product (GNP) of $1 trillion was spent for environmental cleanup. By 1975, the Council estimates that $18.3 billion will be required. For the three areas of air, water, and solid waste, the Council estimates that the total cumulative expenditures during the six-year period will be approximately $105 billion. However, such massive expenditures would only be about 1.6 percent of the estimated cumulative GNP of $6.7 trillion. Only $62 billion, or 59 percent of such costs, would be for meeting air and water quality standards.

It is estimated, based on very limited information, that expenditures for pollution problems related to noise, radiation, and pesticides would add an additional 0.02 percent to total expenditures. Thus, about 1.8 percent of the 1970-75 cumulative GNP, or $118 billion, would be spent on environmental efforts. Investment for capital acquisition is estimated to take 32.7 percent of such expenditures, which would leave approximately $76.7 billion for the total operating costs for environmental programs during the six-year period.

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[6] Council on Environmental Quality, Environmental Quality (Washington, D.C.: U.S. Government Printing Office, August 1971).

Before estimates are discussed concerning environmental jobs based on the amount of money spent to meet pollution standards between 1970 and 1975, the following key points should be understood:

1. The methods used to estimate the number of jobs are relatively crude but do give some approximation as to what might be expected, given a certain level of expenditures.

2. The jobs which are estimated relate only to the aforementioned six areas of pollution control and do not include jobs estimated for the broad categories of natural resource management, environmental health, or environmental planning.

3. The occupational categories for which estimates are made are extensive; i.e., the general grouping of occupations listed as being concerned with the area of science and research is used as a nondiscriminating unit. This means that specific occupations in this area, such as that of a microbiologist, cannot be separated from the overall category of environmental science and research. However, the general composition of that category is made up of microbiologists, physicists, botanists, etc., and is assumed to be included for the purpose of making the overall job estimate for the category. Based on industry data, the composition of a given area, such as air pollution control, can be derived with its own substructure of occupational requirements. This means that in the area of research and design work (involving to a large extent scientists), a substructure of engineers, technicians, operators, etc., can be developed; but specific occupations within the general category cannot be singled out for estimating purposes.

4. Specific occupations listed in the following sections of this chapter go beyond the boundaries of the general occupational structures and categories used in developing estimates for the six areas of pollution control. For example, in environmental education and technology, educators are listed as having a direct concern with teaching people about environmental problems. However, they are not included within the rather confining parameters of the pollution control categories. This is not to imply that such occupations are not concerned or related to environmental problems but only that the parameters of the estimating procedure do not include them.

Given the restrictions of the estimating methodology, however, some general indications for the number of jobs by broad occupational categories related to pollution control can be made. As shown in Table 2-2 and Chart 2-1, the estimated number of jobs in these categories was approximately 800,000 in 1970. Given the amount of expenditures required to meet pollution control standards by 1975, it is estimated that a total of about 1.5 million jobs will be needed--an overall increase of approximately 700,000 jobs, or 87 percent. This estimate implies only the number of new jobs required by 1975; it does not mean that there will be 1.5 million employed. The supply of persons needed to fill such jobs is not included and no attempt has been made to estimate either the supply of persons with environmentally related occupational skills or replacment needs. As pointed out in the discussion on the BLS occupational projections, the replacement needs can be quite significant.

It is estimated that jobs by each of the major occupational categories will grow roughly in the following manner: Environmental science and research occupations are anticipated to increase from 100,000 in 1970 to 193,000 by 1975, a 93 percent

Chart 2-1

Estimated Growth of Required Jobs in Four Categories of Environmental Occupations for Six areas of Pollution Control 1970-1975

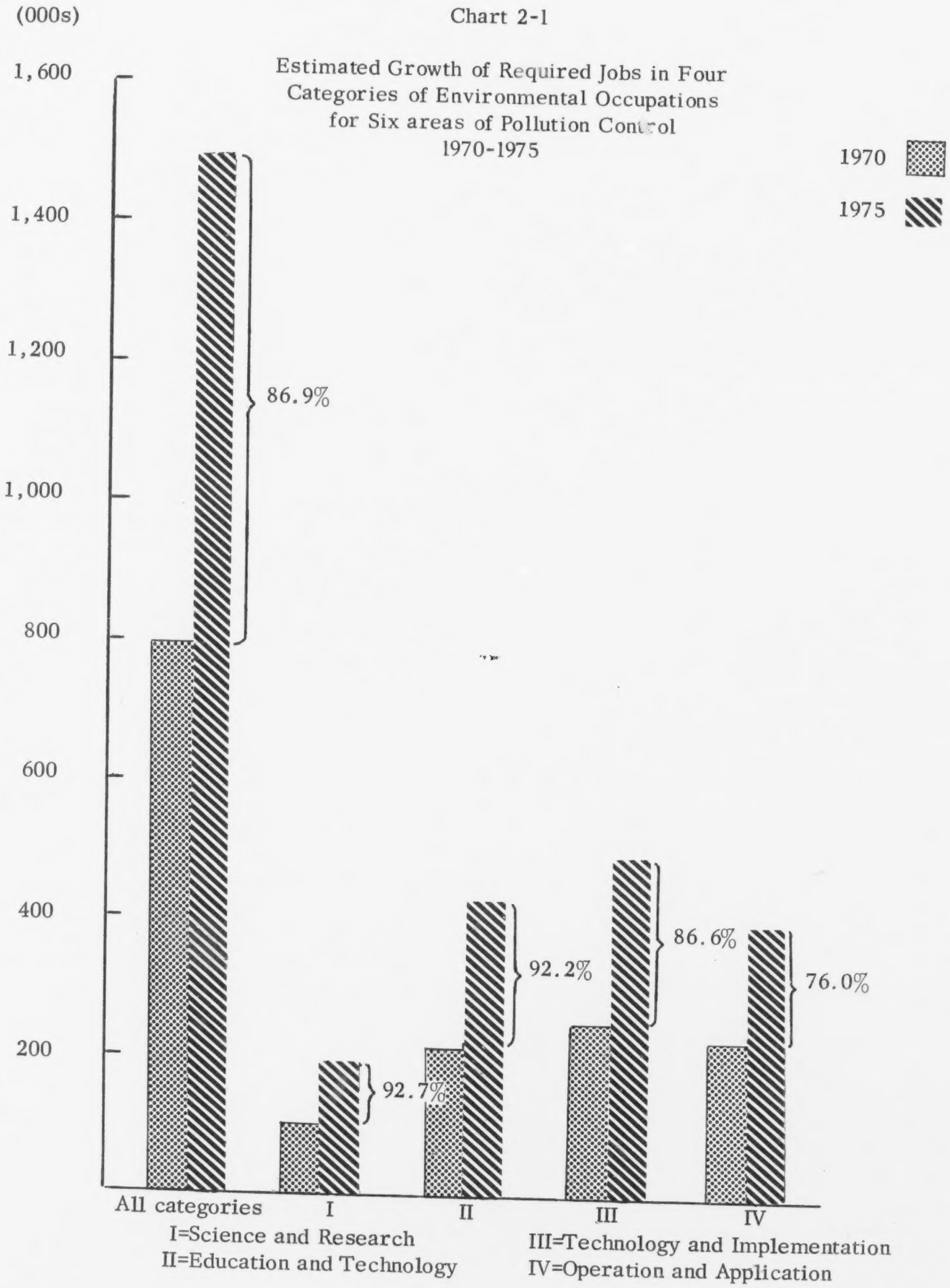


Table 2-2
ESTIMATED ENVIRONMENTAL JOB REQUIREMENTS BY MAJOR OCCUPATIONAL CATEGORY AND SIX AREAS OF POLLUTION CONTROL, 1970-1975
(DATA IN 000s)

Function / Environmental Occupational Category	Total	Air	Water	Solid Waste	Noise	Radiation	Pesticide
1970 Estimate							
Science and Technology	100.0	4.6	20.4	52.5	5.5	14.4	2.6
Technology and Education	222.3	10.2	44.6	118.2	12.2	32.1	5.6
Technology Implementation	255.2	9.7	75.6	137.4	6.7	19.3	6.5
Equipment Operation	224.6	5.8	57.7	144.5	1.9	9.7	5.0
Total	802.1	30.3	197.7	452.6	26.3	75.5	19.7
1975 Estimate							
Science and Technology	192.7	44.1	38.2	72.2	13.5	15.8	8.9
Technology and Education	427.3	97.2	82.5	162.5	30.1	35.3	19.7
Technology Implementation	483.9	92.3	141.7	188.9	17.0	21.3	22.7
Equipment Operation	395.2	55.5	108.2	198.7	4.7	10.7	17.4
Total	1,499.1	289.1	370.6	622.3	65.3	83.1	68.7
1970-1975 Average Annual Growth							
Science and Technology	18.5	7.9	3.6	3.9	1.5	0.3	1.3
Technology and Education	41.0	17.4	7.7	8.9	3.6	0.6	2.8
Technology Implementation	45.8	16.6	13.2	10.3	2.1	0.4	3.2

(continued on following page)

Table 2-2 Cont.

Environmental Occupational Category / Function	Total	Air	Water	Solid Waste	Noise	Radiation	Pesticide
Equipment Operation	34.1	9.9	10.1	10.8	0.6	0.2	2.5
Total	139.4	51.8	34.6	33.9	7.8	1.5	9.8

Note: This table represents new jobs only between 1970 and 1975 and does not attempt to determine replacement needs. Basic assumption is that a certain magnitude of funds will be spent in order to meet environmental standards by 1975--sourced by CEQ and adjusted to include amounts for noise, radiation, and pesticides. Supporting occupations, such as secretaries, data processors, etc., are not included in the estimates. See Appendix 2-3 for statement of methodology.

growth. Jobs in environmental education and technology are estimated to grow about 92 percent, or from 222,300 to 427,300 during the same period. Environmental technology implementation jobs are estimated to increase by 89 percent, a change from 255,200 in 1970 to 483,900 by 1975. A 76 percent growth is expected in environmental equipment operation jobs, or an increase from 224,600 to 395,200 during the six-year period.

Viewed in terms of the average annual growth, job opportunities in environmental science and research occupations will be approximately 18,500 per year. Opportunities in environmental education and technology and in environmental technology implementation should substantially be larger at about 41,000 and 45,800 per year, respectively. The per-year job growth for occupations in environmental equipment operation is estimated to be around 34,100.

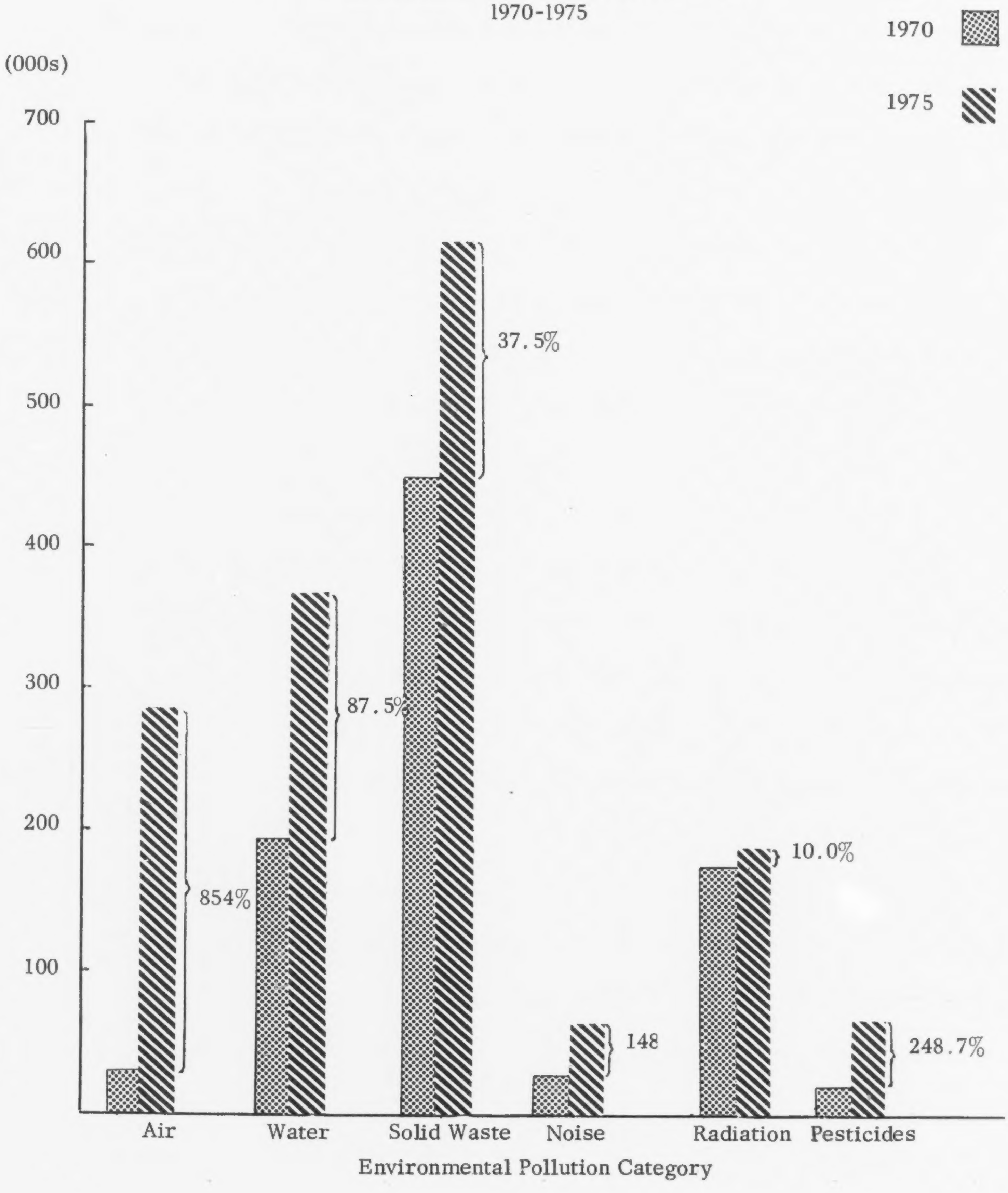
It is important to know not only in which occupational groups but also in which areas of environmental pollution control growth is anticipated. Chart 2-2 shows where job opportunities are expected to grow in the six areas of pollution control. Again these estimates are based on expenditure information by sector primarily provided in the second annual report of the Council on Environmental Quality.

By far the largest gain, in terms of number of jobs and percentage increase, is expected to occur in air pollution control. This area is estimated to grow by 854 percent between 1970 and 1975 if air quality standards are to be met. Jobs are estimated to skyrocket from about 30,300 in 1970 to 289,100 by 1975, an increase of 258,800.

The second fastest growing environmental pollution control area is in pesticides, increasing by 248 percent between 1970 and 1975. However in terms of jobs, it is

Chart 2-2

Estimated Growth of Required Jobs by
Environmental Pollution Control Area
1970-1975



expected to grow from 19,700 in 1970 to 68,700 by 1975, a gain of 49,000. Noise pollution jobs will be the next fastest growing at 148 percent during that same period. The number of jobs, however, will increase by 39,000 from the estimated 26,300 in 1970.

Although smaller in terms of percentage growth, job opportunitities in water pollution control are estimated to grow by 172,900 over the 1970 level of 197,700, percentage gain of 87.5. A fairly large number of jobs are anticipated in the solid waste area, growing from 452,600 in 1970 to 622,300 by 1975, an increase of 169,700, but only a 37.5 percent change. The smallest growth, both in terms of jobs and percent change, is expected in the area of radiation pollution control. Jobs are estimated to grow by only 7,600 from the 1970 level of 75,500, or about a 10 percent change.

The preceding discussion on estimating the number of environmentally related jobs, based on an anticipated level of expenditures, is intended to present a general idea of how the major types of occupational categories might be expected to grow and in what area of pollution control it is expected to occur.

JOB SELECTION CRITERIA

To determine or select courses of study or training geared for particular careers, conscientious students should consider several different factors which have direct bearing on the potential employability in any chosen occupation. The process of supply and demand in any occupation is tenuous and difficult to predict. However, there are certain factors which determine occupational growth patterns to a large extent. These factors vary in intensity and consequence with occupational categories and in general fall into four areas·

1. Many jobs grow or decline in direct relation to the government appropriations in actual dollars spent for enforcing specific projects or programs, created or redirected, relating to those occupations. For example, the demand for air analysts in the immediate future depends upon the amount of dollars to be appropriated by the government enforcing the air quality standards imposed by the 1970 Air Quality Act.

2. Other jobs depend upon the past percentages of the GNP and the federal budget. They grow or decline according to supply and demand as evidenced in the present employment conditions which do not reflect future projections of growth in many occupations. As observed in the field of aerospace engineering, the supply of aerospace engineers began to exceed the demand in the late 1960s. The surplus of engineers has steadily grown; but many economists project that this situation will reverse itself, and the demand will exceed the supply again in the mid 1970s.

3. Other jobs do not grow appreciably but remain somewhat steady, and any growth is merely reflective of the general population growth. Incoming personnel replace only those who have left occupations as a result of death or retirement. Anthropologists are in this category because the relative number of positions in universities, colleges, and museums remains fairly constant. In any given year, there are few new job positions created in this type of profession.

4. Other jobs grow or decline to reflect a fluctuating birthrate. There has traditionally been a greater demand for teachers than the existing supply provided; however, as the birthrate has declined while the supply of teachers has increased, opportunities in the teaching profession presently are limited. Therefore,

the number of teaching positions is diminishing; but this surplus of teachers could possibly be reversed if more potential teachers entered environmentally related fields.

Such factors as parental expectations, individual aptitudes and aspiration, and local job conditions should be taken into account by students who are contemplating career selection. However, public influence is perhaps the most dramatic, as well as the most unpredictable, factor to be considered because environmental occupations will grow primarily upon the public's insistence upon their continuance. It will be this pressure applied to government officials that will cause increasing dollar appropriations through legislation and which in turn will create more environmentally related careers.

The remaining sections of this chapter present descriptions and information on specific environmentally related occupations which have been grouped into four major categories: science and research, technology and education, technology implementation, and equipment operation. This information has been designed to foster potential job seekers' interests in environmentally related occupations. These careers can prove to be personally stimulating and rewarding, as well as constructive, in our fight against environmental deterioration.

II. CAREERS IN ENVIRONMENTAL SCIENCE AND RESEARCH

Broadly speaking, there are two aspects of science: theoretical or "pure" and practical or "applied" science. The theoretical scientists research and discover what could be called basic laws of nature, whereas the practical scientists apply those laws for pragmatic purposes. Both of these broad areas of scientific activity are concerned with the improvement of man's understanding and his relationship with the environment. For the purposes of organizing this section, careers in environmental science and research have been categorized into three general areas: life, physical, and social scientists. Included in each of these general areas will be both theoretical and practical scientists. The criterion employed for the inclusion of a scientific occupation is that the job requires the professional application of existing scientific knowledge, the expertise to practically apply that knowledge, and the development of new scientific knowledge about the relationship among environmental factors and the interaction of these factors with man.

LIFE SCIENTISTS

The life scientist is interested in the study of living organisms and the life processes that determine the nature of living organisms. He is particularly concerned with how the living organism relates to its environment. Some life scientists are involved in research and teaching. Others specialize in the practical solutions to such problems as the development of new plants or medicines. They are primarily concerned with the life processes of human beings and microbes, animals and plants, and health and disease.

More than one-half the estimated 193,000 persons employed in this field in 1970 were employed by colleges and universities. A large number of these people were employed by agricultural colleges and the college-associated experiment stations often operated in cooperation with federal and state governments. About one-third of the remaining life scientists were employed by the federal government in the Department of Agriculture, the Department of the Interior, the Department of the Army, and the National Institutes of Health. A lesser number were employed by state and local governments. Approximately 30,000 life scientists were working in private industry in 1970 in such areas as pharmaceuticals, industrial chemicals, and food products.

A bachelor's degree with a major in one of the life sciences is a basic requirement for entry-level positions. However, students planning a professional career in the life sciences should obtain advanced degrees, preferably Ph.D.'s, in a specific specialty area. A master's degree qualifies a person for entry-level positions in most applied scientific research programs. The majority of universities and colleges have programs that lead to degrees in the life sciences area. For those anticipating advanced degress, their undergraduate training should be broadly based and should include biology and related sciences such as organic and inorganic chemistry. Also, mathematics, physics, and computer programming are becoming increasingly important in this area.

There will be three main areas of strong demand for life scientists in the 1970s. Research related to medicine, health, and environmental quality will be predominant throughout this period. Major expenditures by all levels of government in research and development in this area will provide opportunities for rapid advancement for all life scientists. Industry is also expected to initiate increased levels of research activity relating to federal regulatory requirements and the development of new drugs, chemicals, etc.

A sector that may absorb large numbers of additional life scientists is the academic community; however, this source of demand is unlikely to remain as strong as it has been in the last decade.

The range of salary levels for persons in the life science field is close to the same rate per year as in 1968. The animal ecologist, zoologist, entomologist, microbiologist, pathologist, plant biologist, or botanist rates are all the same. For example, the federal government offered beginning slaries to those with bachelor's degrees of $5,732 to $6,981, depending upon the academic records of the candidates or the desirability of the job locations. Those with master's degrees could expect offers from $6,981 to $10,203 per year. Beginning salaries for those holding Ph.D.s were $10,203 to $12,174 annually. The aquatic biologist is in a higher salary rate scale. Those aquatic biologists holding bachelor's degrees received yearly salaries ranging from $7,456 to $9,078. A job candidate with a master's degree could receive $9,078 to $10,154 to start, while a Ph.D. could bring salary offers of $11,565 to $12,580 per year.

Some of the specific occupations requiring specific career choice and extensive training in the life sciences are discussed below.

Biological Sciences

This group includes occupations concerned with research in the reproduction, growth, evolutionary structure, life processes, behavior, and classification of living organisms. The biological scientist is mainly concerned with the application of his findings to the prevention of disease and with the maintenance and promotion of health in both plant and animal life. His scientific studies also include investigation into the economic utilization of the harmful aspects of specific animals or plants.

Under this general classification, there are many specialists. Some of those occupations most concerned with environmental problems are discussed below.

Aquatic Biologist

The aquatic biologist studies the interaction of plants and animals living in water. All conditions of the aquatic environment, i.e., water temperature, oxygen content, light, food availability, etc., are his concern. The delicate ecological balance can easily be upset, and the aquatic biologist studies methods of achieving or maintaining the sytem's balance. His work is both indoors and out, and he often spends considerable time in and around water. The physical demands of this occupation are generally light. Within this overall group there are also biological oceanographers (or marine biologists) who specialize in the study of plant and animal life and environmental conditions in oceans and seas.

Biochemist

Biochemists study all living organisms and their chemical and biological processes. They are primarily involved in a research-oriented profession that studies the impact of chemical changes on plants and animals. Biochemists isolate, analyze, identify, and report on the minerals, vitamins, enzymes, hormones, etc., that affect the operation of living organisms. Some specialize in certain types of organic functions such as digestion, breathing, and aging. They can specialize in the study of environmental pollutants on living organisms. The biological or chemical pollutants in air and water as well as those in the soil affect the functioning of most organisms. Biochemists have a primary responsiblity to evaluate these effects and suggest remedial action. The work is predominantly indoors, usually in a laboratory or research facility, and requires considerable concentration, patience, and attentiveness.

Biophysicist

The biophysicist is trained in biology andphysics. He is concerned with the physical principles of living organisms and living cells. He studies the organism's response to such physical forces as heat, light, radiation, sound, and electricity. He frequently uses such highly sophisticated equipment and instruments as nuclear reactors or special electron microscopes to study the effects of radioactive particles on tissue cells, which make the studied tissues visible down to the smallest units.

Biostatistician

The biostatistician exerts his influence by planning survey projects, collecting and analyzing data, and summarizing and reporting his findings related to biological phenomena. He is particularly interested in descriptive, measurable data pertaining to animals, plants, and the life processes of humans. He attempts to identify statistically significant relations among and within groups of living organisms that will lead to a better understanding concerning the causes of illness, the effectiveness of disease-prevention techniques, and immunization programs. He is often deeply involved in the public health programs of some local, state, or national jurisdiction. Much of his work is conducted indoors with the assistance of supporting research staff such as various types of research assistants, and he often requires services from persons having computer utilization skills.

Cytologist

The study of plant and animal cells is the special interest of the cytologist. He studies parts of living cells as well as the details of cell division into new cells, using special dissecting equipment, microscopes, and staining techniques. He is also interested in research concerning the reproduction processes of animal and plant cells. Some cytologists may be primarily interested in unicellular organisms and the factors pertaining to their growth.

Geneticist

Hereditary characteristics of plants and animals are the special areas of study for the geneticist. He is particularly involved in the physiological improvement of plants and animals. He studies genetic processes that determine animal, plant, or human traits and characteristics and the factors that can cause malfunctions or distortions. Some geneticists are very concerned with the mutational effects of radiation on plants and animals.

Microbiologist

The microbiologist (sometimes referred to as a bacteriologist) is involved in the study of the growth, structure, and general characteristics of bacteria, viruses, molds, and other organisms of microscopic or submicroscopic size. He conducts experiments by isolating and making cultures of significant bacteria or other microorganisms.

Pathologist

The degeneration or abnormal functions in humans, animals, or plants is the concern and particular area of study of the pathologist. He researches the nature, cause, and development of disease. Many pathologists are primarily interested in the effects of such infestations as disease, parasites, or insects on the cells of animals and plants. Others may be concerned with genetic variations in cells.

Biological Sciences, Animal

Some biologists specialize in one area of biology such as those fields concerned with land animals, humans, or birds. Biologists most concerned with environmental problems in this area are discussed below.

Animal Ecologist

The animal ecologist is concerned with the relationship between animal life and its immediate surroundings. He studies the life cycles of animals and attempts to determine how environmental factors such as plant growth, moisture weather and altitude affect the existence of various groups. This work is very important because of the direct analogies that can be drawn between animals and their environments and man and his environment. Much of the animal ecologist's work is done outside in the process of observation and study; however, a considerable portion of contemporary research is being done on controlled environments that indicate inside work for this profession.

Animal Husbandryman (Scientist)

A person in this profession is primarily concerned with the production and care of domesticated animals. He conducts research into the breeding, selection, feeding, marketing, and other managerial functions concerning animals. He is primarily interested in developing better and more predictable methods of care and management for domesticated animals.

Entomologist

The insect and its relationship to plant and animal life is the primary interest of the entomologist. He studies, identifies, and classifies the various types and kinds of insects. Those insects that carry disease or spoil food products are objects of special research for many entomologists. Others may develop ways to encourage the growth and distribution of such beneficial insects as honeybees.

Pharmacologist

The effects of drugs, gases, poisons, dust, air pollution, and other substances upon the functioning processes of tissues and organs are the research field for a pharamacologist. He conducts tests and related the findings of his research with other medical data and information. Some pharmacologists develop new or improved chemical compounds for use as medicines.

Physiologist

The physiologist studies and conducts research pertaining to the structure and functions of animal organs, tissues, and cells. He studies the life processes and the effects of these processes as they relate to environmental problems. Some physiologists specialize in cellular activities. Others are primarily interested in one of the organ systems such as the reproductive system or nervous system.

Zoologist

The zoologist studies animals, their life origins, and their life processes. He is concerned about animal diseases, parasites, and behavior patterns. He may research the methods animals use to influence and are influenced by their environments. A zoologist may specialize in the study of certain kinds or classes of animals such as birds (ornithologist), mammals (mammalogist), and fish (ichthyologist).

Biological Sciences, Plant

Many scientists specialize in study and research concerning only plant life, their processes, growth, and development, or their relationship with the environment. Some of the scientists in this general category who are primarily concerned with plant life and environmental problems are described below.

Agriculturist

An agriculturist is concerned with both the theoretical and the actual practices of agriculture. He may act as an advisor concerning problems of livestock, crops, breeding, seeding practices, harvesting, etc. He may also specialize in any number of agricultural areas and provide more technical advice to those concerned with environmental problems. The general nature of his work is to provide technical information and to assist others in solving a wide range of problems. While technical knowledge and a broad, practical background in agriculture are essential, the ability to deal with people, handle complex problems, organize, and communicate effectively are most important attributes.

Agronomist

An agriculturist may specialize in a highly technical field such as agronomy. Field crop problems are the particular concerns of the agronomist. He is interested in developing crops of higher quality under conditions of more efficient methods of production. At the same time he strives to maintain or increase the crop yield. He actively seeks hardier crops, disease control, and the reduction of pests and weeds. An agronomist sometimes specializes in such areas as developing production methods or solving crop problems that are peculiar to certain geographical regions.

Botanist

The botanist studies all aspects of plant life. He is mainly concerned with heredity and physiology of plants but is also interested in the economic value of plant life. Botanists usually specialize in technical areas such as plant ecology, the study of environmental elements in relationship to plant life and its distribution; plant taxonomy, the identification and classification of plants; and economic botany, the improvement and development of wild and cultivated plants.

Forest Ecologist

A forest ecologist conducts research and studies vegetation, plants, trees, and environmental factors that affect the forest. He attempts to determine what conditions account for the prevalence or absence of different varieties of trees. He studies specific tree classification and plant life history. The forest ecologist is interested in the light and soil requirements and the resistance to disease and insects of different species of trees. He investigates the adaptability of different species to any new environmental condition that occurs, such as changes in climate or altitude or changes in the type of soil.

Horticulturist

Problems concerning the growth and marketing of edible products of plants as well as the plants themselves are the primary concern of the horticulturist. He is also interested in the development of new or improved varieties of commercial plants. Some horticulturists are involved as technical advisors for the commercial use of plants. Others are involved in basic research on plant growth and development, usually at experimental farms. Other areas of specialization are the ornamental horticulturist who creates and develops plant and flower display areas and artistic gardens. The concern of the ornamental horticulturist is to improve the aesthetic qualities--particularly the color, shape, and quantity of blooms--of ornamental shrubs and flowers.

PHYSICAL SCIENTISTS

Another major area of environmental science and research is that of the physical scientists. These scientists generally are engaged in one of the following areas: basic research, the application of basic research to the development of new processes and products, or teaching the supervision of research and the development of applied programs. Most of the physical scientists work in laboratories, classrooms, or offices; but some occupations require working outdoors in the "field" where there may be hazardous working conditions. Dangerous field work demands professional competency and following safety procedures designed to reduce hazards.

Physical scientists are concerned with the basic components, structure, and processes of our environment; therefore, they have a major impact, both directly and indirectly, on our approach to solving environmental problems and our understanding of the environment per se. Some knowledge of physical science is fundamental to obtaining an environmental education. Consequently, such people as teachers of physical science play a major role in developing public understanding and awareness of environmental problems.

The majority of physical scientists are employed by private firms engaged in development and utilization of the earth's natural resources. A large number of them, however, are employed by the federal government, colleges, and universities. A few are also employed by state and local governments and by nonprofit research institutions.

Entry-level positions in this area generally require a bachelor's degree in one of the basic physical sciences. Advanced degrees, either masters or doctorates, are considered highly desirable and frequently are required, particularly for advancement and for positions with additional responsibility such as directing research activities or teaching.

It is expected that there will continue to be a steady demand for physical scientists of all types. Some segments of this field are closely tied to the defense industry and will flucturate according to the emphasis placed upon the military programs. A change in national priorities to environmental or social service problems may require a change in emphasis and could even alter the specific job description of some positions in this field.

Salary scales for physical scientists do not vary greatly and are within relatively close proximity. In 1968, private industry paid a wage rate approximately 20 percent higher than governmental agencies. For example, the federal government's starting salary for a geologist holding a bachelor's degree was $7,456 to $8,845 annually depending upon his academic record. Private industry starts a geologist at a minimum annual salary of $7,800.

The federal government started chemists, hydrographers, meteorologists, and astronomers at $7,456 to $9,078 for those holding bachelor's degrees. A master's degree could bring offers ranging from $9,078 to $10,154, while a Ph.D. would be $11,563 to $12,580 per year. A physicist could expect from $8,000 to $9,000 annually, with a bachelor's degree, $10,000 with a master's degree, and $12,000 to $14,000 per year with a Ph.D.

Some of the specific occupations of interest in this handbook are discussed below.

Astronomer

The astronomer observes, studies, and interprets the phenomena that occur within and outside the universe. He also interprets research and basic scientific knowledge for application to such practical problems as those in navigation. He is particularly concerned with computations pertaining to the positions of the sun, moon, planets, stars, nebulas, and galaxies. An astronomer may be particularly interested in the study of the movement of objects in our solar system and how this motion relates to the phenomenon of gravitation. With this information, he can calculate the orbits of artificial satellites and the paths of guided missiles.

Chemist

The diversity of the chemist's work defies precise description. He is concerned with the properties of matter, its composition, internal relationships, and application.

This encompasses virtually every aspect of the universe and man. In a more pragmatic sense, he searches for knowledge about chemical substances, and based on this knowledge, he devises practical applications that contribute to the improvement of our living standards. He studies, plans, organizes, writes, and discusses his research activities and its results. There are five main branches of chemistry: inorganic, organic, analytical, physical, and biochemical. Most chemists, however, specialize in only one branch. A chemist generally works inside laboratories of various types, but occasionally he may work outside. There can be hazardous working conditions involved, but such dangers can be minimized by professional competency and by following safety procedures.

The application of chemistry to solving environmental problems is readily apparent and well known. Specialists in this area are identified by titles such as water, sewage, sanitation, or soil chemists. However, a more general application of chemistry to environmental problems occurs through research on developing chemical control pollution processes and products for industry and business. As most industry attempts to conserve resources and, in recent years, to reduce pollution emissions, chemists play key roles in these activities.

Analytical Chemist

The analytical chemist is involved in conducting research to develop or improve analytical techniques, methodology, and procedures. He is particularly active in the investigation and application of instruments to analytical procedures in determining chemical and physical properties of organic and inorganic compounds. He helps establish and improve procedures for quality control tests and analysis.

Inorganic Chemist

The inorganic chemist primarily conducts experiments on substances that are free from carbon--such as metals, ores, gases, and heavy chemicals--to develop and improve such materials for productive purposes.

Organic Chemist

The organic chemist conducts experiments with substances of which the essential element is carbon, such as paint, rubber, wood, dye, petroleum, etc. The field of organic chemistry includes as one area of specialization the agricultural chemist who conducts research in chemical problems related to commercial agriculture. His work includes protecting crops against infestation, promoting soil conservation, eliminating soil poisons, developing better and less harmful insecticides, fungicides and rodent poisons.

Geologist

A geologist studies the structure, composition, and history of the earth's crust. He may spend a substantial amount of time in fieldwork (sometimes under adverse weather conditions) studying rock cores and cuttings; examining rocks, minerals, and fossils; locating mineral and petroleum deposits and underground water resources; and studying the floor of the ocean. He may also spend considerable time in a laboratory and use sophisticated scientific instruments, including the X-ray diffractometer and the petrographic microscope. A geologist prepares reports, articles, and maps of surface and subsurface phenomena. He may be an administrator of research and exploration programs. A geologist can teach in a college or university where he frequently combines teaching with working on research projects.

Because the earth's crust is one of the major components of our environment, the work of the geologist can have a direct impact on our understanding and utilization of this aspect of the environment. This is particularly true of exploration and consumption of oil and natural gas, a major portion of a majority of the geologist's work. The research and exploration done by a geologist can often be the basis of activities for other environmental occupations discussed below:

Assayer

The assayer is concerned with testing ores and alloys. He analyzes the results of the tests and determines the values and properties of precious metals. In conducting the tests, the assayer uses standard laboratory equipment and chemical solutions.

Geodesist

The geodesist is concerned with studying and measuring the size, shape, and mass of the earth. He determines the positions and elevations of points on or near the earth's surface and measures the intensity and direction of gravitational attraction. From this data he prepares topographical maps and establishes bench marks (known points of elevation).

Geophysicist

A geophysicist studies and analyzes the earth's atmosphere and hydrosphere to determine the effect that changing climatic, thermal, seismic, radiation, pollution, and electric conditions have on the earth. He may also analyze the structure and composition of the earth's interior. His studies encompass the origins of glaciers, volcanoes, earthquakes, etc., and from studies of this type, he attempts to determine appropriate water supply, irrigation, and flood control programs. The geophysicist is intimately involved in the cyclical nature of the earth's environment, and based on his understanding of this interaction, he is in a unique position to help contribute knowledge toward the solution of major environmental problems.

Hydrographer

The hydrographer performs activities primarily related to the study of water resources. He samples, measures, and tests river levels, water flow, silt accumulation, water temperature, and water control equipment. Based on his studies, he prepares reports with supporting recommendations. The hydrographer works closely with meteorologists in the measurement of rainfall, water runoff, etc. Much of the hydrographer's time is spent outdoors. The hydrographer applies his expertise in the control and utilization of water resources. He frequently tests for purity of surface and underground resources. A hydrographer can apply his efforts to developing flood control measures, erosion prevention, irrigation, and other water supply uses. The hydrographer can, therefore, apply his talents in several areas of pollution control and resource conservation.

Metallurgist, Physical

The physical metallurgist is concerned with investigating the properties and treatment of metals in order to develop new alloys. He is also involved with developing new uses for existing metals and alloys and is particularly concerned with developing methods for their commercial use.

Meteorologist

The meteorologist studies the atmospheric phenomena of the earth. He is interested in and attempts to describe and explain the motions, components, influences, and processes of the atmosphere. This science is comprised of many constitutent parts, some of which are: aerology, climatology, and synoptic, dynamic, and physical meteorology. Some of these specialties are research oriented and some are application oriented. The climatologist is research oriented; he interprets statistical data on the wind, rainfall, sunshine, temperature, and other aspects of the climate of a particular area over an extended period of time in order to predict the future climatic conditions of the area. He develops and uses statistical data and other methods to analyze and interpret climatological data. The major component of the latter group is the synoptic meteorologist or the "weather forecaster." Most of his activities are performed indoors, using highly complex meteorological equipment.

The study of air--its composition and its motion--constitutes the basis for understanding air pollution and its potential correction. A meteorologist can play a major role in the analysis of air pollution problems. He also can contribute to the understanding of the causes of water pollution, airborne movement of pesticides, etc., but to a lesser degree than what he contributes to the general understanding of air pollution.

Mineralogist

Examining, analyzing, and classifying minerals such as gems and precious stones are the special interests of the mineralogist. He is also concerned with developing data and theories on the mode of origin, the occurrence, and the possible uses of minerals.

Oceanographer

An oceanographer studies the ocean, its contents, and its movements. He plans and conducts extensive tests and surveys. The results of his studies serve many industries, both private and public. His studies often involve the development of maps, charts, tabulations, scientific reports, and papers. He needs and uses many different kinds of specialized equipment to study the ocean. He is often involved in the development and design of such instruments. An oceanographer spends varying amounts of time on ships at sea. These excursions can last from a few days to many months.

Most oceanographers specialize in one of the highly technical fields of this work . Those specialty areas which are primarily concerned with the environment are: biological, physical, and chemical oceanography or marine meteorology. With the expanding demand for a better utilization and preservation of our oceans, it is anticipated that oceanographers concerned with the environmental specialty fields will be in demand during the 1970s.

Physicist

The field of physics conveys a wide and varied body of knowledge. Generally, a physicist works in either theoretical or experimental physics or in applied basic research. A theoretical physicist is involved in developing theories of the relationships between energy and matter and expresses these theories in equations and mathematical terms. An experimental physicist is involved in observations and experiments, often attempting to validate or invalidate the related theories. In applied physics, the physicist is actively involved in the practical application of the knowledge gained from basic research. The three fields are interdependent, and the difference is largely dependent upon the emphasis placed by the physicist.

Some specialty areas such as nuclear physics can occasionally be hazardous. A physicist has usually specialized in one of the branches of the science and often applies the theories and methods to other scientific disciplines and the particular problems originating in those sciences. Furthermore, applied physics has increasingly merged with other fields, such as engineering. It is therefore readily apparent that basic training in physics is fundamental to the entire ecosystem and most of the related careers in environmental sciences.

Seismologist

The seismologist studies the structure of the earth's interior and the vibrations of the Earth caused by earthquakes, volcanic eruptions, and man made explosions. Using special devices and machines, including the seismograph, he establishes the existence of active fault lines or areas where earthquakes have occurred and near which it would be hazardous to build cities, dams, or tall structures.

Soil Scientist

A soil scientist is concerned with soil productivity and the management of soil. He is particularly interested in the development of possible alternative practices of soil use. He classifies soil and determines the soil's capabilities for use in growing different product and crops. A soil scientist often examines and solves problems such as soil drainage and soil usage as needed for foundations for roads and other structures. Much of his work is outside.

SOCIAL SCIENTISTS

The social sciences are concerned with all facets of human society and institutions. These sciences deal with the research, analyses, and evaluation of historical and current economic, social, and political aspects on man's existence and relationship as a member of an organized community. Generally, social scientists specialize in one basic area of redundant study, such as anthropology, economics, geography, sociology, or political science. Persons engaged in these various fields are becoming increasingly concerned with the environmental aspects of human activity and how social action can be brought to bear on environmental problems through man's organizations and institutions. Although some fieldwork may be involved in the various social sciences occupations, the majority of this work is usually conducted in offices or classrooms.

Educational requirements needed to enter the various fields in the social sciences are usually bachelor's degrees. Advanced degrees such as masters or doctorates are usually required for jobs such as teaching in a university or in positions of high responsibility in government or industry. The majority of job opportunities for social scientists are found in colleges, universities, and government. There will be a growing need for persons trained in the social sciences during the 1970s. A particular growth will be in the governmental sector as increased emphasis is placed on developing public programs and investments that have an impact on social as well as technical solutions to making beneficial use of our resources while protecting and preserving the environment.

Salaries for those in the field of social sciences vary depending upon the amount and quality of education and the particular field of specialty. Another variable is the employing institution. For example, an economist with a bachelor's degree received a beginning salary from the federal government of from $5,732 to $6,981 in 1968. An economist with a master's degree started at $8,462. Economists with experience earned from $10,000 to $20,000. In colleges and universities, the median salary was $15,700; in private industry, $18,000.

In the federal government, a geographer with a bachelor's degree started at between $5,732 to $6,981. With some experience, such as graduate teaching, the starting salary was somewhat higher--at $6,981 to $8,462. Mathematicians, who were in higher demand in government agencies, started at $7,265 to $8,845 with bachelor's degrees, $8,845 to $10,154 with master's degrees, and $11,563 to $12,580 for a Ph.D. An anthropologist with a master's degree began at $8,462; a Ph.D. at $10,203. Many experienced anthropologists earned from $12,000 to $20,000 annually. A psychologist with a Ph.D. and limited experience started at $12,243. The annual salary in the Department of Medicine and Surgery, Veterans Administration, which requires Ph.D. degrees in all specialties, was about $16,300 for psychologists.

Some of the occupations of interest in this area are discussed below. For the purposes of this handbook, mathematicians and statisticians have been included in this grouping.

Anthropologist

The anthropologist studies the origin, development, characteristics, languages, material possessions, beliefs, customs, and the structure of man's social and value systems. He may specialize in a given area of work; however, a general knowledge of all anthropological areas is usually expected. For example, the physical anthropologist brings to bear extensive training and skills in anatomy and biology in studying the differences or similarities of man's evolution. For example, he studies the differences in physical stature and characteristics among different races and groups of mankind. He is also concerned with the environmental conditions in which man lives and functions, ranging from the design of automobile seats to space suits. Another specialty in anthropology is called "ethnology." The ethnologist studies and usually lives with primitive tribes for periods of time in order to learn about their social customs, organization, human relationships, and material possessions. Recently, ethnologists not only have been involved in the comparative study of various primitive cultures and societies but also have studied the complex conditions and interactions of people in present-day urban societies, with particular concern for the human value systems that are held regarding their environment.

Economist

The economist is primarily engaged in the study and evaluation of man's activities directed toward satisfying his material requirements. He is concerned with the problems of the efficient use of scarce or limited supplies of land, materials, manpower, and natural resources and in meeting the demands for those supplies. An economist develops or uses theories and models by which economic activities can be examined and assessed and by which plans, policies, and programs can be made regarding the intelligent and effective use of land, labor, and capital.

An economist can apply his expertise in virtually all of the environmental problem areas, but the most important contribution is in terms of conservation and proper use of natural resources. The economics of urban planning, industrial location, taxation, etc., all provide avenues of application to solving environmental problems. An economist specializing in these and other areas is becoming increasingly important in the planning, implementing, and evaluating of pollution abatement projects and resource conservation measures.

Geographer

The geographer works primarily in the study and analysis of the Earth's physical characteristics, such as terrain, vegetation, soils, water, minerals, and their relationships to the patterns and distribution of human habitation around the world. A geographer uses a broad range of different disciplines and skills to analyze man's relationships with the environment. He studies man's geographical dispersion such as ethnic distribution, economic activity, and political organization. Specialization in one main area of geography is usually the case, such as urban geography. There is also a special field of geography which deals with the development and design of maps showing physical and environmental characteristics of certain areas.

Mathematician

Mathematics can be classified into two major work classes: theoretical or "pure" and applied mathematics. A theoretical mathematician seeks to develop mathematical principles and defines relationships among mathematical forms. Such abstract knowledge is extremely significant in its practical application by scientists and engineers. In applying mathematics on a practical basis, theories and techniques are developed to solve problems in such areas as social sciences or physical life. Mathematics is a very important discipline that can be brought to bear on reaching quantitative analysis and solutions to environmental problems, ranging from designing better or more effective devices for reducing air pollution or providing mathematical models of environmental systems, how they operate, interrelate, and can be connected when problems occur.

Political Scientist

A political scientist studies and evaluates all levels of government: what they do, why they do it, and how they do it. Since the growing concern for environmental protection and preservation has kindled a vast public interest, the programs and actions that governments develop to attack environmental problems and regulations can be aided by the skills of the political scientist. Most political scientists are employed by colleges and universities, but some serve in various capacities in government. A political scientist is trained to analyze public attitudes and to deal with factors which influence public opinion. Some political scientists work as legislative aides for congressmen or as staff members of congressional committees. Political scientists can help in the research and drafting of laws directed toward environmental control and protection.

Psychologist

A psychologist is concerned with the individual, his development, his problems, and his behavior. Psychologists are employed by government, by business, and by industry to assist with testing, counseling, and problem solving. Some of the more important areas in which psychologists may contribute to solution of environmental problems include studies of individual reactions to urban crowding and other societal changes, analysis of factors leading to behavior which is not ecologically sound, and guidance regarding the steps necessary to alter traditional patterns of human behavior to bring them more in harmony with environmental demands.

Sociologist

A sociologist is interested in the study of the many groups that humans form. He studies communities, states, families, tribes, and other organizations, including those of a social, religious, political, or business nature. He is interested in how individuals are affected by the organizations to which they belong. A sociologist may study intergroup relationships, family problems, population characteristics, and the effects of urban living on urban social conditions.

Statistician

A statistician is basically concerned with describing the characteristics of the world and its inhabitants in terms of numbers and measurements. He develops, collects, compiles, analyzes, and interprets data according to statistical procedures developed by mathematicians. Whenever it is necessary that information be gathered, analyzed, or treated in quantitative form, a statistician's skills are usually required. He is extremely essential in dealing with the quantification and analysis of environmental problems. Fields of statistics include such areas as demography, life sciences, physical engineering, medicine, behavioral sciences, and many others.

Writer

A writer is responsible for many of the formal communications which occur within a society, particularly those communications which take place through the mass media. He may be a student of a new science called communicology which deals with the nature of communications, their effects, and how they may best be utilized. The writer plays an important part in keeping the citizens of the world informed regarding environmental problems, their potential dangers, and their possible solutions.

III. CAREERS IN ENVIRONMENTAL EDUCATION AND TECHNOLOGY

The application and dissemination of contributions from those persons engaged in environmental science and research are highly dependent upon another group of occupations classified in this handbook as dealing with environmental education and technology. These jobs are concerned with the transmission and application of knowledge, techniques, and findings emanating from the scientific and research areas. Occupational fields included in this grouping are educators, engineers, some health jobs, planners, and persons concerned with the management of natural resources.

Since educational requirements, working conditions, and places of employment vary a great deal among these occupations, they are discussed within each of the general categories.

ENVIRONMENTAL EDUCATORS

The environmental educator has attained a high degree of expertise in environmental problems and has chosen the education field as a means to transmit his knowledge to citizens of all ages. The environmental educator can teach at all levels, depending on his professional preparation. Usually, he incorporates teaching environmental issues into the framework of one or several related disciplines, such as biology, economics, chemistry, etc. He usually is responsible for developing an acceptable curriculum and must administer the tests and supplementary classroom procedures. The classroom is his predominant work area, but occasional oudoor activities such as field trips are likely in some schools.

The environmental educator is thought to be the only real hope of a long-term, rational solution to the environmental problems. The problems associated with environmental awareness and the way the problems are attacked are caused by the attitudes of people. The environmental educator has a major task in generating the type of curriculum that will sustain a person's interest in solving these problems and will develop a personal commitment on the part of every citizen to take corrective action.

The number of environmental educators is very small if only those actively engaged in this profession on a full time basis are counted. There are some educators with specialties in other areas that are spending at least part of their teaching time in education on environmental problems. Most full time environmental educators are in major colleges and universities. To date, there are few established curricula at the secondary school level except on pilot bases. Therefore, there are significant areas for applying teaching skills to students at all levels. It seems reasonable that there will be increased emphasis on teaching environmental education in the secondary schools as well as in post-secondary institutions. To demonstrate the emphasis on environmental education, the National Science Foundation funded training programs for more than 1,000 precollege teachers in 43 states and the District of Columbia in 1971.

Approaches to the solutions of environmental problems must take a multidisciplinary approach. It is difficult to specify any particular subject areas as being more important than others. An environmental educator must be well versed in the physical sciences, economics, and political science. Sociology, psychology, the humanities, and other social sciences should be included in a well-rounded curriculum. Teaching at the secondary level requires at least a bachelor's degree. Jobs in the institutions of higher education require a master's degree or a Ph. D.

Environmental problems are virtually certain to become worse before they become better. The role of the environmental educator with his background in many fields is likely to expand well beyond the classroom. He is certain to become a center of community attention in all discussions on this topic. If he responds to the challenge with reasoned expertise, movement into school administration positions or positions in related public agencies is highly likely. Some of the occupations identified in the area of environmental education are discussed below.

Camp Counselor or Recreation Manager

A camp counselor largely directs the recreational and vocational activities of children or adults at vacation camps or at various types of work camps. He organizes and leads groups on sports, nature lore, and similar outdoor recreational activities. The counselor instructs campers and other group members to improve their proficiencies in many sports and other camping acitivities. He is concerned with safeguarding the health of campers. It may at times be necessary for the counselor to maintain discipline and otherwise guide the conduct of the juvenile campers.

The camp counselor can be instrumental in developing human awareness to environmental problems and environmental activities. It is at the parks and in the natural areas of our nation where people can learn about and develop an appreciation for conservation and pollution control. The counselor can guide the learning into productive channels of activity.

The camp counselor works primarily outdoors. The work is sometimes of a strenuous nature. Therefore, students anticipating this occupation should have and maintain excellent physical condition. The work at times may be hazardous; but with adequate training and with reasonable preparation and caution, this need not be a significant factor.

Humanities Teacher

A teacher whose classes are concerned with branches of learning having primarily cultural characteristics (such as English, composition, literature, drama, art, and music) can be helpful in directing students' attention to environmental problems. By directing the students' studies to visual or written material which is environmentally focused, he is able to educate and direct their attention to the promotion of human welfare through clutural reform in all areas. There is a host of material available and currently being used by humanities teachers in such forms as essays, fiction, poems, articles, paintings, sculpture, and architecture.

Life Sciences Teacher

The life sciences teacher instructs students in the characteristics of living organisms and the relationships between them and their surrounding environment. This knowledge is at the heart of any understanding of environmental education. Of particular importance is the technical and general understanding of what kind of changes in a given part of an ecosystem has an impact on the other parts of the system. This knowledge is important both to enable the general public to put into perspective and to comprehend the implications of environmental problems and to provide a solid educational foundation for the high percentage of students whose later occupations will have either direct or indirect impact upon the environment. The work is primarily accomplished indoors with an occasional field trip to sites of interest. The amount of activity is dependent upon each individual teacher's particular teaching style.

The average salary received by a teacher in public secondary schools in 1968 was from $8,160 to $9,500. Vocational education , physical education, and other specialty subject teachers occasionally earn more than regular teachers. The average salary in 1968 for a teacher in a college or a university was $8,934. The following briefly describes two of the major branches of the life sciences division of environmental education.

Biology Teacher

The biology teacher focuses on animal and plant life. He instructs students in the development, heredity, physiology and environmental distribution of living organisms. He teaches the effects of environmental factors such as rain, temperature, and climate upon animals and plants. The teacher prepares his students to recognize specific environmental problems and possible solutions to those problems. He can frequently be instrumental in encouraging students to go on to specialized careers relating to environmental problems such as horticulture, plant ecology, animal husbandry, or wildlife management.

Physiology Teacher

The physiology teacher instructs a branch of the biological sciences which emphasizes the processes, activities, and other phenomena that are characteristic of life and living matter. He orients his students to cell structure and the organ-system functions of plants and animals. He is primarily concerned with teaching the effects, both internal and external, of environmental conditions and problems. By focusing on these aspects, he is able to provide more specialized knowledge which will help the students prepare for environmentally related careers

Physical Sciences Teacher

The physical sciences teacher educates his students about the nonliving aspects of our environment. In this capacity, he inculcates into students an understanding of the interrelationships which all segments have with each other. He may also provide examples of current environmental problems that involve the specific branch of physical sciences which he is teaching. This educational area is basic to the knowledge required for eventual careers in environmentally related occupations. In addition, it can help provide a citizenry that is cognizant of environmental concerns and capable of comprehending technical environmental problems.

Each branch of the physical sciences has a particular scope of and therefore provides its own approach to environmental concerns. The following briefly describes some of the major branches of physical sciences teaching:

Chemistry Teacher

The chemistry teacher discusses the properties, composition, and internal relationships of matter. He teaches about the various aspects of atoms and molecules, and the peculiar characteristics of specific substances, and demonstrates how different substances react with each other. The chemistry teacher helps students to learn chemical principles, techniques, and methods. The students learn laboratory procedures by actually conducting experiements and tests under the direction of the chemistry teacher. A basic understanding of chemistry is fundamental to other branches of physical sciences.

Geography Teacher

Geography is useful to give students an overview of the entire environmental picture. A geography teacher demonstrates the total distribution patterns of plant and animal life--including man--which includes the comprehension of the intricate interrelationships of the ecosystem on a large scale. In addition, he gives a more detailed understanding of the characteristics and actions of the land, sea, and air, which are also essential to a basic understanding of the environment.

Geology Teacher

A geology teacher discusses the structure, composition, and history of the earth's crust. This generally involves studying rocks, minerals, fossils, and geological formations. He teaches students how to identify and to determine the many sequences and processes that were causative in affecting the development of the earth. As a major element of our environment, this field is pivotal to the basic understanding of either the general or technical aspects of environmental education.

Physics Teacher

The study of physics is concerned with the relationships between energy and matter in the fields of mechanics, acoustics, optics, heat, electricity, magnetism, radiation, atomic structure, and nuclear phenomena. The physics teacher can challenge students to experiment and to devise methods in the application of physical laws and theories to the problems of the environment. A basic understanding of physics is fundamental to the science of engineering as well as many other technical fields.

Public Health Educator

The public health instructor is concerned with educational methods that provide learning opportunities and experiences for individuals and groups in the community who are concerned with health programs. He is primarily interested in getting health facts accepted and used, stimulating the public to be interested in public health programs. He also aids individuals and groups in setting up effective procedures that use public health knowledge, reduce hazardous conditions, or actively improve existing programs. The public health teacher works to coordinate activities between the public, voluntary, civic, and professional agencies.

The major environmental contribution of the public health teacher is in alleviating some of the problems associated with the impact which the environment has on each individual's health. He can provide valuable discussions concerning sanitation, air, water, and noise pollution impacts.

Social Sciences Teacher

The social sciences teacher is concerned with education related to the origin and development of groups of human beings. He instructs students about the patterns of human culture and the social organizations that invariably result. He is particularly interested in human patterns as they relate to environmental problems. Such knowledge and understanding can be of particular concern in the attempt to reduce many sources of pollution. The spatial distribution of people and their activities have an effect on the physical environment, and the comprehension of these phenomena by students is critical to the development of possible environmental solutions.

Vocational Teacher

The vocational teacher provides basic theory to students and assists in their development of manipulative skills in industrial arts. He uses lectures, illustrations, or demonstrations to teach the proper use of shop tools and machines. The vocational teacher is particularly concerned with safety practices and theory as applied to industrial arts. A teacher usually specializes in one or more areas, such as woodworking or metalworking, electricity, graphic arts, automobile mechanics, or mechanical drawing. He prepares students for technical or vocational careers which have an impact directly or indirectly on the environment.

The work is primarily accomplished indoors with only an occasional field trip to sites of interest. The work can at times be hazardous when working with some tools and machines; however, with careful and adequate preparation and training, this need not be a significant factor.

ENVIRONMENTAL ENGINEERS

Engineers are concerned with the application of scientific principles to a wide range of problems, including those of the environment. They engage in research, development, design, and production of equipment, techniques, buildings, and other types of goods and services that require the application of engineering principles and methods. Some engineers are concerned with such factors as the production of useful products at the most reasonable costs in terms of time and money. Other engineers are engaged in inspection for quality and control. Some are active in the planning and supervision of construction projects such as buildings or highways. Still others function as salesmen in highly technical fields.

Because engineers are concerned with converting the earth's raw materials and energy resources into useful, economically feasible products, they are intimately involved with the environment. Generally speaking, this involvement is critical at several points in the process, namely in the extraction, conversion, disposal, or elimination of wastes and in the functional and aesthetic design of the final product. As will be seen in the more detailed descriptions under each of the specific engineering categories, the skills and attitudes of the engineers at these and other points along the production line are major determinants of the shape and nature of our total environment.

More than 75 percent of all engineers are employed by private industry; the remainder, by federal, state, and local governments and by nonprofit institutions such as universities, colleges, and research organizations. More than half of the engineers employed by the federal government work in the Department of Defense. Most engineers in state or local government agencies are hired by highway and public works departments.

The generally accepted standard of background training to enter the engineering profession is the completion of requirements for a bachelor's degree in engineering. Advanced training, is needed for many positions, present and future. Some specialty fields, such as nuclear engineering, are taught only at a few schools and some only at the graduate level. Entrance requirements for undergraduate work necessitate a high quality of work in high school, with courses in mathematics and physical sciences.

Some institutions require more than four years in an undergraduate program. Usually such programs have a work-study component so that the student spends more time in actual employment while obtaining a degree. Most graduates begin work as trainees or as assistants to experienced engineers.

Government expenditures for defense is a significant determinant in the demand for engineers (approximately 30 percent).

Therefore, those engineers who do not have diversified backgrounds in engineering principles or those whose specializations are very narrow could be adversely affected by defense spending shifts. This could also apply if there were a rapid change in technology.

Employment opportunities for engineers are expected to be moderate for the next decade, based on the assumption that defense spending will be somewhat higher than it was prior to the Vietnam buildup in the early 1960s. There will probably be an especially strong demand for engineers schooled in the newest techniques and procedures as well as those who can apply these principles to the medical, biological, and other related environmental sciences. The average salaries for beginning engineers in 1968 were $9,200 for those with bachelor's degrees, $11,000 for those with master's degrees, and $15,000 for Ph.D.s.

Aeronautical Engineer

An aeronautical engineer engaged in a career relating to environmental problems is involved in the design and development of aircraft which decrease the amount of air and noise pollution. He usually specializes in one or several phases of work such as testing, propulsion, structural design, materials analysis, or similar activities. He is concerned with all aspects of the development of aircraft and related aerospace devices and may specialize in certain types of air craft - jet, conventional propeller driven, military, or commercial.. However, there is considerable flexiblity among these specialties that can allow for internal mobility.

An aeronautical engineer works primarily indoors with some study and observation occuring in and around aircraft and their components. This type of engineering is not considered physically demanding. Where the environment is concerned, aeronautical engineers can most effectively use their skills in the prevention or reduction of air and noise pollution.

Agricultural Engineer

An agricultural engineer's work can apply in both the areas of pollution control and resource conservation. He is interested in applying engineering principles to obtain more efficient design and use of agricultural equipment, farming techniques, the use of electrical and mechanical devices to farming methods, and the efficient use of soil and water resources. An agricultural engineer usually specializes in one or more aspects of resource conservation and pollution control such as testing, application, research and development production, or management. Depending upon the particular specialty, his work can be either indoors or out and can be highly physically demanding. The development of efficient agricultural techniques can result in reduced visual, air, and pesticide pollution and an increase in production output. Conservation of soil and water resources through well-planned irrigation systems, efficient plant cover, and crop rotation are all within the domain of agricultural engineering.

Expanding population and increased emphasis on resource conservation and pollution control are likely to stimulate the demand for agricultural engineers. The increased use of solid wastes as agricultural resources and the rapid expansion of power and energy requirements on modern farms will also add to the overall demand. Therefore, a modest upward growth in employment of agricultural engineers is anticipated.

Chemical Engineer

A chemical engineer applies the principles of chemistry and engineering in the design of plants and machinery that are required to transform, measure, or manufacture chemical products. In this type of activity, he often uses pilot plants to facilitate the design, development, and testing of a particular process. The diversity of this branch of engineering requires specialization. Some of the most frequently entered instruction in chemical operations are hydrogenation, oxidation, and polymerization. A chemical engineer may specialize according to industry or product as well. The paint, drug, rubber, and petroleum (and their by products) industries are examples. A chemical engineer works primarily indoors, but occasional projects require outdoor activities with possible hazardous industrial confrontations.

The rising need for water and air purity, chemical treatement of solid waste products, and improved production techniques to conserve natural resources provides a major challenge to a chemical engineer. There is ample room for specializing in one or more of the above categories, and there will be continual demand for those entering these areas. There is also a vast untapped area of research and development associated with the environmental problems in which a chemical engineer plays a vital role.

Civil Engineer

The civil engineer primarily engages in the planning, designing, and overseeing of major construction projects such as roads, dams, airports, bridges, water and sewage systems, waste disposal units, irrigation projects, etc. He must act in the capacity of coordinator and inspector as well as perform the primary responsibilities of physical construction, sometimes inside and sometimes outside, but a large portion of his work is outdoors. There can be, but usually is not, heavy manual labor involved. There may be occupational hazards in some types of construction projects under the civil engineer's direction. Due to his wide applicability, he is found in all geographical areas, has opportunities to travel widely to both internal and foreign projects, and can expect to be engaged in a variety of different projects simultaneously or in succession.

In many respects, a civil engineer may be viewed as a "general" engineer because he is capable of understanding and seeing to completion many types of projects. In the environmental area, construction of water facilities, sewage treatment plants, waste disposal units, etc., are of foremost importance. There is apparently little demand for specializing in this aspect of civil engineering because other specialized engineers--such as sewage treatment engineers, water supply engineers, sanitary engineers, etc.--can provide the technical inputs to the construction effort. Rather, the civil engineer must be equipped to plan, organize, coordinate, and inspect construction projects of this type with their unique problems.

Combustion Engineer

The combustion engineer designs heating equipment that will efficiently burn fuel, then test it in the burning process. He attempts to determine which fuels are best suited for a specific process that will provide optimum resource and minimum fuel consumption. The combustion engineer works primarily indoors, but can encounter hazards in the course of his activities. The work is not generally physically demanding.

Minimizing resource usage by efficient burning and energy conversion processes and maintaining a minimum level of air pollution pose a major challenge to the combustion engineer. Consequently, he must perform his functions while being cognizant of pollution and resource conservation.

Electrical or Power-Plant Engineer

The engineer who works with electricity and power has many varied and interesting opportunities available to him. He is responsible not only for the generating plant facilities but also for interconnections of power systems, installation of new systems, and expansion of existing plant facilities. He may supervise new construction as well as develop and improve plant methods. Engineers are responsible for the selection of appropriate types of fuel, design of plants, and the location of plants. He is interested in and concerned about the efficient use of power and the maximization of energery generated at the plant.

The majority of engineers in this specialty field are employed by public utilities firms. In this role, they play an important part in reconciling the ever-increasing demands for electrical power with the increasingly stringent demands for aesthetically pleasing construction of such facilities and concern for the maintenance of the natural environment. The federal government and private industry are employers of other engineers in this area.

Environmental Engineer

The environmental engineer specializes in applying engineering principles, methods, and practices to environmental problems for the purpose of protecting and improving man's living conditions. This engineering specialty includes the control of natural resources (such as air and water) and the control or manipulation of man's environment in relation to his health and social and economic well-being. Some environmental engineers specialize in applying engineering principles to the maintenance of systems that support life in alien or hostile environments which occur in space or in subterranean areas of the ocean. With the increased emphasis on environmental concerns, it is anticipated that jobs for these engineers will grow in fairly substantial numbers during the next decade.

Geological Engineer

The geological engineer applies his knowledge to engineering problems in the construction of roads, airfields, tunnels, dams, harbors, and other large structures. In that capacity he is responsible for maintaining the best balance between preservation of the geological environment and for identifying the nature and extent of any damage that may occur. Much of his work is done outdoors at the job site, but frequently he must supply detailed reports and supportive data for recommendations.

Hydraulic Engineer

The designing and construction of large power, irrigation, and navigation projects that control as well as use water is the special interest of the hydraulic engineer. He must compute and estimate the flow rate of water and specify the correct type and size of needed equipment. Some hydraulic engineers are particularly interested in the evolution of streams, rivers, or open waters by such methods as dredging or digging. They frequently design and build new or artificial channels for water distribution such as reservoirs, canals, dams, etc. Much of their work is done in offices or laboratories but also can involve fieldwork.

Industrial Engineer

All three aspects of the productive process (manpower, machines, and material) are in the domain of the industrial engineer. He plans, organizes, and designs systems or techniques relating to complex production and organizational problems. In this capacity he uses data processing techniques and operations research methods to adequately perform the job. He has a variety of supplementary activities involving design of quality control methods, safety systems, and time and motion studies. Most of his work is done indoors and he can be exposed to hazards typical to the particular production process with which he works.

At the present time the industrial engineer is not likely to use his skills in the solution of environmental problems. He can however apply his knowledge to developing more efficient productive methods that will conserve resources, and can design and develop productive processes that do not pollute on an objectionable scale.

Industrial Health Engineer (safety and sanitary)

The industrial health engineer is engaged in planning, analyzing, coordinating, and reporting on health conditions in a plant or industry. He applies the relevant principles of engineering to analyze and control conditions influencing occupational hazards and disease. He must analyze all conditions involving radiation, dust, fumes, noise, vapors, solvents, gases, etc., that are known or suspected of being deterimental to health. He must suggest or recommend methods of remedial or preventive action. Part of his responsiblities include the supervision of workers engaged in development and maintenance of conditions in compliance with health standards. Occasionally, the industrial health engineer acts as a consultant to a management or governmental body. He works primarily indoors and can encounter hazards associated with processes producing the above types of conditions.

The industrial health engineer can apply his expertise to development and maintenance of a healthy and external work environment. His activities can serve as an example of what and how a project can be done. He is primarily responsible for using his knowledge to identify conditions that are or can be detrimental to all living organisms, internal and external, in the industrial plant, the agricultural industry or the educational institution.

Mechanical Engineer

The mechanical engineer performs varied functions which generally include the production, transmission, and use of power. He is concerned with all aspects of power utilization and the instruments that use power. Jet engines, rockets, internal combustion engines, and nuclear reactors are included in the production process; transmission lines, transformers, and various mechanical devices in the transmission segment; and elevators, refrigerators, air conditioners, and a wide variety of power equipment in the power use category. Some mechanical engineers specialize in one or several of these processes and work mainly in offices and laboratories.

Development, use, and conservation of energy through mechanical means with the minimum amount of waste or pollution basically summarizes what mechanical engineers attempt to do. Application of engineering principles and mathematical tools to the solution of environmental problems is their primary function. Their knowledge spans the entire spectrum of pollution problems, and they can apply their expertise to the solution of water, noise, and radiation pollution.

Mining Engineer

The mining engineer is involved with the location and extraction of minerals from the earth. He designs the specifications and supervises the construction of mines. He is responsible for all aspects of the mining operation: safety, power, water, communications, and equipment maintenance. Some mining engineers specialize in a particular phase of the mining operation such as the extraction of specific ores or other products (coal, oil, etc.). Others engage in research activities or teach at colleges or universities. Much of their work is done outdoors where they are occasionally exposed to hazardous situations.

The mining engineer can contribute to the efficient use of the Earth's mineral supplies by developing machinery capable of properly extracting minerals on extensive and intensive bases. He is also concerned with resource conservation of air, water, and land, with particular emphasis on restoration of areas scarred by strip mining.

Nuclear Engineer

The nuclear engineer is involved with scientific research and its application to problems in the use and controlled production of nuclear energy, and is particularly concerned with the hazards of using radioactive materials in nuclear reactors. He is involved in the design, function, and operation of nuclear reactors, but may also work with jet, steam-turbine, and internal-combustion engines. Some specialize in the processing, disposal, and safety control aspects of radioactive materials. Nuclear engineers are often found in supervisory positions.

The nuclear engineer's major challenge is the reduction of thermal pollution in water and the control of radioactive emissions into the atmosphere. He can therefore play a major role in the research and analysis of water and air content. To a lesser degree, some of these engineers are involved in the research and analysis of the effect of some aspects of water and air pollution as it relates to the health of animal and plant life. As a result of such research, some nuclear engineers are actively working to use this knowledge in the designing of safer nuclear equipment and facilities.

ENVIRONMENTAL HEALTH

People involved in the environmental health category may work directly with persons who are ill, with organizations which want to protect their employees, with companies that are creating health hazards, or with groups which are attempting to resolve industrial-environmental conflicts. The exact nature of the work varies considerably, depending upon the specialty of the individual. Those involved in this field may be located in an office, hospital, laboratory or plant.

One of the major concerns of those working in this area is the impact that environmental pollution may have on people's health. There are a number of different occupations concerned with the linkages between health and the environment. Such work may involve determination of how to change harmful environmental conditions or to mitigate the adverse effects caused by them.

Most people involved in environmental health are employed by various governmental agencies or by private companies. The major exception is doctors, who are generally in private practice. There are, however, an increasing number of physicians who specialize in environmental health and are employed by private and governmental hospitals, state and local health departments, medical schools, research foundations, and professional organizations.

The education levels required of those involved in this field vary, but are generally quite advanced. A bachelor's degree may be adequate for entry into some positions, but graduate work in some specialized field is helpful and frequently required. For example, the education and training required for a physician is graduation from an accredited school plus a license to practice medicine, the minimal requirement in all states and the District of Columbia. The large majority of states also require a one-year internship with an accredited hospital. In addition, many states require candidates to pass an examination in the basic sciences to qualify for the medical licensing examination. Most medical schools require three years of college education for admission to their regular four-year programs, and some require four years. A few schools allow exceptional students to enter medical school after two years of college.

Trends point to an ever-increasing demand for specialists engaged in environmental health-related occupations. The present relative growth of the service sector of our economy, coupled with the increasing demands for all environmentally related occupations, projects significant opportunities for those who are able to meet the educational requirements.

Dietician and Nutritionist

The dietician specializes in determining well-balanced and nutritious foods required for the health and proper functioning of the human body. Nutritionists specialize in educating people concerning nutrition and related food habits. Although the dietician and nutritionist work in different settings, they are both concerned with similar basic knowledge and are attempting to accomplish the same goals. Often they are involved in the special nutritional needs of persons who are recovering from surgery or disease or who are chronically ill. Dieticians are frequently involved in the supervision of food purchasing, handling, and cooking. Some dieticians and nutritionists are involved in basic research.

Graduate dieticians with internships had beginning salaries of $7,500 in 1968. Nutritionists in 1964 began at $5,500. With experience, a nutritionist in 1964 made upward of $10,000 per year.

Field Health Officer

The field health officer concentrates his efforts on identifying, tracing, and reporting cases of communicable diseases. He advises affected individuals where and how to obtain medical assistance. Part of his work is to interview and report on the incidence of communicable diseases, where the disease was contracted, how fast it spread, etc. The field health officer works both indoors and out and is often requested to do extensive travel within a particular area. He contacts individuals of all types and must be capable of communicating effectively with them. There is a significant possibility that he may be exposed to diseases, and this constitutes a serious occupational hazard. He primarily works for various types of public health agencies, with significant opportunities for work in foreign countries, particularly in underdeveloped areas.

Industrial Hygienist

The industrial hygienist works closely with industrial health engineers and occupational physicians to ensure a healthy work environment in plants or industry. He conducts health programs to eliminate health hazards or control diseases. Part ot his responsibility is to collect and analyze various toxic elements such as vapors, gases and fumes that are dangerous or potentially dangerous to health. The entire work environment, including noise, radiations, disease prevention, and pollutants, are of concern to him. Based on his studies and findings, the industrial hygienist must prepare reports, instigate educational programs, and submit recommendations for prevention of industrial hazards. The primary work environment is the plant where he is employed and its associated laboratory facilities. The industrial hygienist is exposed to potentially hazardous conditions throughout the investigation and analysis of health hazards.

While the plant working environment is the area of primary importance to the industrial hygienist, he must also be cognizant of and react to changing conditions external to the plant. Similarily, he must consider the impact of internal waste disposal procedures on the external environment. In pollution abatement procedures, he must be well informed about the internal generation of pollutants and how disposal can properly be accomplished with a minimum amount of deterioration to the surrounding environment.

The hygienist with a bachelor's degree earned $6,000 in 1968. With more training and experience, salaries range upward to as much as $20,000 or more.

Physician

The physician diagnoses and treats individuals who are ill or injured and is concerned with the rehabilitation of his patients. He generally examines and treats the patient in an office, the hospital, or on occasion, in the patient's home. A growing number of medical doctors are becoming concerned with environmental medicine and occupational health. Other physicians are engaged in research, teaching, and the administration of hospitals and professional organizations. Most of the environmental specialists work fewer hours than the physician who enters private practice.

Where health and safety are concerned all aspects of the ecosystem come into consideration and the role of the medical doctor is varied. He is concerned with communicable diseases, safety, and the effect of environmental pollutants such as radiation and its effect upon the health and safety of all living organisms. This involves not only the management of pollutants but critical research concerning prevention.

Graduates of medical schools working as interns earned $4,893 to $5,030 per year in 1968. With internship completed, the federal government paid $13,300 and $15,800 upon completion of one year of resident training. Private practice earnings are similar.

Sanitarian

The sanitarian is concerned with planning for the cleanliness, safety, and enforcement of laws concerning handling, dispensing, and consuming food. He plans and conducts programs related to sanitation and encourages the enactment of regulations and laws that promote positive health standards. He works closely with other health specialists (such as public health nurses, engineers, food and drug inspectors) to prevent outbreaks of disease or to plan for emergency situations if such outbreaks or a disaster occur. Some sanitarians in large and heavily populated areas may specialize in a particular area of work, i.e., food, waste disposal, air pollution. In rural areas, they are responsible for a wide range of environmental health activities.

Sanitarians usually spend a good portion of their time "in the field." Sometimes they come into contact with unpleasant surroundings, such as sewage disposal plants, refuse dumps, etc.

Sanitarians with a bachelor's degree earned about $7,000 per year as a starting salary in 1968. With experience, they earned upward of $10,000. Sanitary aides earned from $6,000 to $8,000 per year. The federal government beginning salaries for sanitary aides was $5,732 to $6,321.

Toxicologist

The toxicologist is primarily concerned with the detection and analysis of toxic substances that are present in environmental areas. He must be capable of performing chemical analysis of blood, body tissue, and other substances to ascertain the presence and amount of toxic agents. Based on his findings, he prepares reports and recommends methods of reducing or eliminating the toxic substance from the affected organism. He works predominantly indoors and is exposed on occasion to potentially harmful agents. His reports must be sufficiently detailed and complete as to be acceptable in criminal investigations.

The toxicologist conducts research in all pollution areas but is most effective in air and water pollution. He identifies the effects of air-and water-borne agents on the health of workers and residents in a particular location. In this capacity, he must determine the toxic content of fumes, dust, mists, and water by performing qualitative and quantitative analyses on these substances.

ENVIRONMENTAL PLANNERS

Americans are becoming increasingly conscious of the importance and need for well planned facilities and surroundings, particularly with regard to expansion of metropolitan areas, increased use of parks and other recreational areas, and urban planning and renewal. As man continues to build and encroach upon natural areas, there will be an ever-increasing demand for people to determine how best to integrate that expansion with the existing environment. There is also a need to improve our relationship with the environment where urbanization already exists. Specialists in this field plan and direct the construction of individual buildings, developments, or whole areas in such a way as to mitigate the adverse effects of construction and natural environment upon each other, thus providing an aesthetically pleasing and functional relationship between the two. Their work is primarily in planning and designing a functional facility or area of use to man while attempting to minimize the adverse effects of such investments on the environment.

Specialists in this area are usually self-employed professionals such as the architect and landscape architect. The urban planner is usually employed by local, state, or federal government agencies. Large land developers are beginning to avail themselves of the environmental planner's services.

The general educational requirement for those interested in this field is a formal baccalaureate program of four to six years' duration. The usual program progresses from a general liberal arts course to a heavier emphasis on courses such as art, mathematics, social studies, science, etc. Graduate training leading to a master's degree is becoming increasingly important.

Beginners in the field usually start with routine jobs, working up to jobs that are of gradually increasing complexity and responsibility. The prospects for rapid advancement in this field are very good. Expanding residential construction, city planning, and urban development will provide career stimulus for planners of all types, many of which will require specialized training.

The salary structure for environmental planners is varied. An architect, beginning as a draftsman for a senior architect, earned from $100 to $150 per week in 1968. Other architects with many years of successful practice, good reputations, and in high demand earned as much as $25,000 or more per year. Landscape architects with a bachelor's degree started at between $7,000 and $9,000 per year; a master's degree or a Ph.D. brought correspondingly higher salaries. The urban planner started a little lower at between $6,800 to $7,800; beginning with a master's degree planners would receive about $7,100 per year in 1968. In cities of more than 500,000 people, the average annual salary of planning directors was $19,000 and ranged to $30,000.

Architect

The architect plans and designs structures of all types in accordance with the requirements and tastes of a particular client or group. He must plan the building so that it will be functional and structurally sound, will fit into the surrounding environment, and will be efficient in use and pleasant to observe. The architect prepares blueprints in conjunction with consulting engineers and landscape architects and in accordance with prevailing building regulations. He works primarily indoors, but may frequently be requested to make on-site examinations of the proposed structure. Architects may work alone or in small groups, but there is a growing tendency toward the development of large architectural firms that can handle very large projects.

Architects can play a crucial role in intelligently using and developing the man-made physical aspects of our environment. Designing buildings may require a consideration of noise pollution. Planning facilities to manufacture industrial goods demands specific considerations of the impact that such facilities is likely to have on surrounding areas. Architects design and in many cases supervise the construction of waste treatment facilities. In virtually every instance, the architect lays the groundwork for further development. In this capacity, he must be cognizant of the environment and what he can do to improve the physical relationships within it. All 50 states require a license to practice architecture, and the licensing requirements differ from state to state.

Landscape Architect

The landscape architect plans, designs, and in many cases supervises the transformation of land areas into useful and attractive sites. He designs the appropriate combination of water, trees, land, and structures to facilitate the intended use of the environment. Efficient use as well as aesthetically pleasing design are his primary goals. Parks, playgrounds, shopping centers, resorts, campgrounds, and the like are all within the domain of his profession. In conjunction with the overall design, he provides working drawings, cost estimates, and necessary materials. He works primarily indoors except for the necessary supervisory activity, usually in the later stages of a project's development.

The landscape architect provides at least two important contributions to the solution of environmental problems: He provides aesthetically attractive areas that reduce visual pollution, and he attempts to use available land in the most efficient and functional manner.

Urban Planner

The urban planner is concerned with the density, usage, congestion, access, deterioration, development, decline, or growth of urban areas. The professional urban planner tries to remedy these problems to more effectively use existing space and to provide for a more functional and appealing appearance of an urban area. He also attempts to estimate a city's long-range needs to ascertain the problems of the city in the future. He is active in guiding and controlling community development as well as remedying current problems and conserving existing areas of historical value.

The majority of urban planners are employed by local units of government such as city, county, and metropolitan. An increasing number are being employed by state and federal governments. A few are also doing private consultation work, which occupies at least a portion of their time.

NATURAL RESOURCE MANAGERS

Those who are involved as managers of the country's natural resources are in direct contact with the natural elements of our environment. They are vitally concerned with preservation and conservation principles, techniques, and methods. Therefore, analyzing existing and potential problems of resource deterioration and devising remedial programs occupy much of the natural resource manager's efforts. To aid the process of problem identification and analysis, they maintain a constant inventory of the quantity and variety of resources under their jurisdiction. Often it is necessary for other governmental or private groups to tap their conservation expertise when these groups are involved in other types of environmental problems.

The natural resource group of occupations have direct control and management responsibility for a major portion of our environment. Besides serving as technical advisors, natural resource managers must be able to determine what types of action or effects are required to modify, protect, conserve, or improve our country's land, water, vegetation, and wildlife resources.

The work of natural resource managers is usually accomplished out-of-doors and requires physical aptitude and abilities. They sometimes face hazardous conditions and must be able to respond to emergency situations. Natural resource managers are exposed to all types of climatic conditions; therefore, excellent health and a love of outdoor life is a necessity for any of these occupations.

Natural resource managers are primarily employed by both federal and state governments to manage our nation's public lands. A much smaller percentage work for private industry engaged in the development of natural resources, teach or do research in colleges and universities.

Educational requirements vary from some post-high school education in a specialized field to advanced degrees. For other positions, the desired training can best be acquired on the job or by employment in related occupations. Generally, however, a bachelor's degree is adequate for entry into these professional careers. Curricula generally include a basic foundation in the physical and life sciences, courses in various aspects of management, and more technical courses in areas of specialization.

The burgeoning increase in the population and the consequent encroachment of urbanization, coupled with the increased awareness of the public to the importance of environment, bode well for the occupational area and may portend a drastic increase in the demand for people who couple this academic background with managerial skills in the natural resources area.

Wage information, as of 1968, indicates that foresters have a salary scale that ranged from $4,700 to $6,000 per year for those with a bachelor's degree to maximum salaries that may exceed $10,000 for supervisory positions. The park ranger or naturalist has a beginning salary somewhat higher at $5,000 per year. The beginning top salary for the park ranger stabilizes at approximately $6,000; however, some rangers earn up to $10,000 per year. The soil conservationist starts at approximately $5,500; however, some conservationists started at $7,000 per year in 1968. Wildlife managers had starting salaries somewhat higher than soil conservationists, ranging from $5,500 to $7,200 annually.

Fish and Game Warden

The fish and game warden is primarily involved with maintaining and protecting the laws that govern use of natural resource areas. Enforcing game law, apprehending violators, and investigating reported incidents of damage to crops, property, and wildlife occupy much of his time. The warden may travel by car, boat, airplane, horse, or on foot to observe and monitor hunters and fishermen. He actively works to ensure that methods used by sportsmen are lawful and the equipment is safely operated. When violations occur, he may serve warrants, make arrests, and often must prepare and present evidence in subsequent court actions. Sometimes it is necessary for him to seize illegal or improperly used equipment.

The warden is also engaged in collecting information and reporting on the condition, habitat, availability, or absence of the wildlife populations under his jurisdiction. He sometimes addresses or speaks to students and other interested groups to assist in the education and general improvement of public relations for the U.S. Forest Service. He is vitally concerned with promoting safety, and often provides training and materials describing safety rules, proper hunting and fishing methods, and information regarding the protection and harvesting of various forms of wildlife.

Forester

The varied activities of a forester are centered around the creation, preservation, and management of the nation's forests for recreation and economic purposes as well as the enjoyment of scenic grandeur. He plans reforestation projects; maps and surveys forest areas (making projections of anticipated future growth and future needs); plans timber-cutting programs to ensure efficient methods; inspects timber cutting processes to ensure compliance with planning schedule; often directs fire fighting activities and subsequent restoration projects; plans and directs the development of parks, campsites, picnic areas, etc.; and undertakes active measures to prevent soil erosion, floods, tree diseases, and pests. His work is often highly physical, requires constant exposure to all climatic conditions, and can be hazardous.

The forester is intimately concerned with the total environmental preservation field. He is directly involved in the prevention of water and air pollution and is primarily responsible for the conservation of forests, efficient use of land and mineral deposits, and the development and preservation of natural attractions. Of the many careers in the environmental area, the forester and forestry technicians are in a group that must approach a total involvement with the environmental problem.

Oceanographer

The study of the ocean and its characteristics, movements, and properties are the interest of people who engage in this occupation. They observe and study the ocean's animal and plant life, conditions and physical properties of the water, and the total effect of related environmental influences such as weather, pollutants dumped into the ocean, and overharvesting of fish, etc. They actively attempt to gain and extend basic scientific knowledge about the oceans' uses and resources. They can provide information and knowledge that can improve the intelligent use of the oceans' resources. They test, observe, and collect data, then analyze and report their findings to interested groups and agencies.

Most oceanographers specialize in one of the many areas in this field, such as biological, physical, or geological oceanography. They are involved in two areas of environmental concerns: conservation and pollution control. They use highly technical and complex instruments in accomplishing their work.

Oceanographers may work in an office part of the time or aboard a ship where they may use diving equipment, aqualungs, etc., to conduct their research work. Most oceanographers spend part of their time aboard research ships and sometimes on voyages that can last three months or more. This specialized field is expected to grow rapidly in the 1970s.

Park Ranger--Naturalist

The park naturalist is mainly concerned with coordinating the various activities, exhibits, and displays in public parks. He is also involved in providing information about the historic, scientific, and natural aspects of the park through lectures, tours, and visual aids. Often he is responsible for the permanent or seasonal park staff and directs their activities. The park naturalist works both indoors and out, and, as a result, is exposed to all kinds of climatic conditions. He is responsible for emergency situations and the protection of human and animal life, government property, and the natural features of the park, which can on occasion expose him to hazardous conditions.

The park naturalist is actively involved in all phases of the environmental preservation field. He is vitally concerned with the proper use and preparation of the natural resources of the park and is constantly striving to reach a balance between use and preservation. He is concerned about safety procedures and may conduct educational programs to educate the park users in proper safety principles and methods.

Range Manager

The range manager is responsible for the utilization, husbandry, and improvement of the nation's rangelands, which cover nearly one billion acres in the United States and represent a substantial national resource. Therefore, one of the range manager's responsibilities is to continually research and study maintenance procedures, searching for improvement in the current methods of range development, utilization, and preservation. He writes reports and provides other forms of technical assistance to the owners of privately held grazing lands. Other management duties include such activities as determining livestock grazing patterns, seeding and planting methods, restoring or developing methods, fire protection, and pest control procedures. Sometimes he will plan or direct range improvements with new or maintenance type construction. In some multiple-use areas, it may be necessary for the range manager to perform some functions of monitoring and inspecting for misuse or trespassing of the public rangelands. Sometimes his work overlaps into other allied professions such as recreation, watershed management, or forest management.

Soil Conservationist

The soil conservationist is interested in and concerned with the productivity, general management, and alternative practices of soil use and conservation. He studies and classifies various types of soil and determines the soil's capabilities for growing different products and crops. Many soil conservationists identify and analyze problems related to such things as land drainage and use of soils in foundations, roads, and other types of construction and structures. He is frequently requested to supply technical assistance to private property owners such as farmers or ranchers not only in the United States but also in foreign countries. He inspects watershed lands in an attempt to pinpoint possible trouble spots where flooding or other problems are likely to occur. He is responsible for preparing reports with suggestions for preventive or corrective action.

The soil conservationist, as his title implies, makes a direct contribution to all aspects of environmental protection and improvement that are related to soils. His work is particularly important in preventing soil deterioration and in maintaining both functional and aesthetically pleasing ground cover.

Watershed Manager

The watershed manager is responsible for the management and maintenance of the country's large water storage facilities such as reservoirs and aqueducts. One of his prime responsibilities is to monitor and control the water level in the storage facility and to regulate flow rate. He also regulates water flow for flood control and irrigation purposes and determines the degree of release required to maintain flow, pressure, and elevation at specified levels. He regulates machinery and turbine engines in hydroelectric plants, frequently monitoring the meters and gauges and performing minor maintenance and repair work as it is needed.

Another major concern of the watershed manager is the territory from which the water flows. He is equally responsible for the care and maintenance of this area, and sometimes it is necessary for him to patrol it. He not only inspects the equipment located there, but watches for trespassing or illegal use of the area and checks for damage from burrowing animals, rodents, pests, or other wildlife.

The watershed manager controls the chemical content of the water purification-maintaining processes, usually on a day-to-day basis, thus making one of his greatest contributions to water conservation. He often supplies data to supervisory personnel for any problem identification and corrective action.

Wildlife Manager

As state, local, and federal governments establish and develop more areas for wildlife refuges, parks, forests, and game lands, the role of managing and caring for such areas becomes increasingly important. Professional wildlife managers are employed by the owners of private game preserves. Such positions will likely be more plentiful as more private clubs and areas for sportsmen are established. The wildlife manager plans for the planting of vegetation, not only for animal feed but also for protection of the wildlife area. He plans and supervises the construction of water sources for animals, and sometimes is involved in determining the number of animals that may be seasonally killed without damaging the propagating power of the species. In this role, he frequently must take count (or census) of game within the reserve, projecting future shortages or surpluses. In this line, he serves the conservation aspect of environmental conditions in maintaining the balance of nature and attempts to ensure that all species are maintained in existence.

IV. CAREERS IN ENVIRONMENTAL TECHNOLOGY AND IMPLEMENTATION

Some environmental occupations rely heavily on people trained as technicians, implementers, testers, inspectors, and analysts. These are the doers, the ones who test theories and actually implement environmental ideas into programs and projects. They also monitor, inspect, and analyze various programs and projects, continually giving the planners or researchers data from which necessary adjustments can be ascertained. Technicians, testers, inspectors, and analysts are the skilled artisans of knowledge, the helpers of research, and the technical appliers of scientific findings, and little could be accomplished if it were not for the implementers of technology.

The three general categories in this section are: the inspectors and monitors, the technicians, and the testers and analysts. The required education, experience, places of employment, and salaries varies; consequently, for the purposes of this handbook, we have chosen to discuss these subjects under each of the three categories. Adequate and current salary information on many of the occupations is unobtainable; therefore, in several occupational descriptions, this information is not given.

INSPECTORS OR MONITORS

The importance of the role of an inspector or monitor in the environmental field cannot be overemphasized. These people serve a critical area in the improvement of the environment and the conditions in which we live. Inspectors provide the necessary link between the theory and the application of techniques. It is through their continual monitoring and inspecting that we are provided with information on the effectiveness, safety, accuracy and efficiency of our machines, equipment, and systems. Positions in this field generally require some academic training and on-the-job experience.

The inspector or monitor frequently must perform detailed and repetitive tasks to complete his responsibilities. Inspectors are more concerned with the detailed and specific application of scientific knowledge and theories and must analyze data and conditions to evaluate systems and make recommendations for alterations or changes. The monitor or inspector must be continually aware of current methods and new adaptations for the specialized systems in which he works. In addition, he uses equipment or procedures involved in public health and safety. Inspectors use a wide variety of instruments, many of which are complex.

The formal training and education required for these occupations varies according to the particular product or system that is being inspected or monitored. Some jobs require highly skilled people with extensive college or graduate backgrounds. Others, especially those that use automatic testing equipment, can be accomplished by relatively unskilled persons. A few jobs can be learned only through on-the-job experience and the development of a solid background in practical "know-how" in the problems that are unique to that specialty area.

The greatest majority of inspectors are employed by local, state, and federal agencies, such as legal enforcement agencies and the Food and Drug Administration; however, private business employs a significant number of inspectors to assist in keeping industrial practices current and valid (especially in the food and drug industries).

The advancement potential for inspectors, especially in the areas of environmental health, is favorable for the next decade. Indications show that there is a growing need for standards of control, and the necessity for enforcement of these standards will produce a demand for trained personnel in protective service occupations. As the complexity of these occupations enlarge, the necessity for more academic knowledge will correspondingly grow; therefore, it is wise for students interested in this type of work to obtain a solid background of scientific studies during high school. It would also seem probable that more and more specific types of short-time training may be required, depending upon the particular specialty. This on-going training could be a prerequisite to qualification for advancement.

The rate of earnings for inspectors and monitors in 1968 was very close. Most workers received from $6,000 to $7,000 a year, depending upon such variables as experience, educational background, geographical location of the job, and particular specialty area. For example, after six years of experience, a water inspector earned between $7,500 and $10,200 annually.

Environmental Inspector (air, water, land, solid waste, industrial, noise, pesticide)

The inspector dealing with various aspects of our environment, such as air, smoke, water, and waste, is primarily concerned with determining environmental purity by using a variety of mechanical and chemical tests. He is guided by regulations and statutes that establish standards for environmental contamination. He analyzes and reports on the samples and data that are collected. Frequently he makes recommendations for corrective action or reports his findings to appropriate enforcement agencies to instigate legal action (where conditions warrant). He frequently must act in an advisory capacity to an establishment that may be bordering on a violation of standards.

Although most specialize in one area, such as noise or solid waste, the environmental inspector is also concerned with the entire environment as it relates to his specialized area. He must be cognizant of and react to changing conditions external to his field of interest. For example, a solid waste inspector must be well informed on the generation of pollutants and their proper disposal with a minimum amount of deterioration of the surrounding environment. And the pesticide inspector has to be aware of the varying demands placed on the need to control pests yet the equal need to maintain standards of ecological balance and high quality at all levels.

Food and Drug Inspector

The food and drug inspector inspects establishments that sell, process, handle, or store products destined for consumer use to ensure quality, purity, and sanitary conditions. He may inspect the physical facilities, the cleanliness of the personnel, and the products to ascertain if compliance with federal, state, and local statutes is being maintained. Reports are typically prepared on the findings, and recommendations for legal action can be instigated if conditions warrant. He can act in an advisory capacity to any establishment that may be facing a violation of standards. Several specialized pieces of equipment are used by the food and drug inspector such as special filtering devices, ultraviolet lights, and microscopes. The conditions of work are generally indoors, though considerable travel is usually required. Occupational hazards are minimal even though the inspector may be exposed occasionally to contaminated products.

Careful inspection of commodities destined for human consumption can reveal the existence of toxic chemicals such as pesticides, radiation, and other impurities. The food and drug inspector must be cognizant of all regulations pertaining to the safe levels of toxic agents in food and how they can safely be disposed of. His activities primarily relate to inspection of food but can extend into areas of water quality standards, waste disposal methods, etc.

Health Inspector or Monitor (sanitation, disease, safety, food and drug)

Inspectors who are involved in the area of protective health services are concerned with planning for the cleanliness, safety, and enforcement of laws concerning the handling, dispensing, and consuming of food. Some inspect establishments that sell, process, handle, or store products that are destined for consumer use. They are concerned with ensuring the quality of food as well as making certain that sanitary conditions meet health standards.

Inspectors plan and conduct programs related to the identification, analysis, and correction of sanitation problems. They can be helpful in providing information leading to the laws and regulations designated to promote adequate health standards. Reports are typically prepared on their findings, and recommendations are made for legal action if conditions warrant. Inspectors may also act in an advisory role to establishments that may be violating food or health standards. They must work closely with other health specialists (public health nurses and engineers) to help prevent outbreaks of disease or implement plans for such emergency situations.

Their work is generally done indoors, although considerable travel is usually required. Sanitarians usually spend a good portion of their time in the field and may specialize in a particular field such as food waste disposal and air pollution. Occupational hazards are minimal, even though the inspector may be exposed occasionally to contaminated products.

Nuclear Inspector (nuclear waste, radiation level, nuclear safety)

The radiation monitor inspects and monitors the plant facilities, environment, and personnel to detect the degree of radiation exposure and contamination. Some are primarily concerned with nuclear waste products and the contamination levels in the surrounding environment. Inspectors use radiation detectors such as the beta-gamma survey meter, gamma-background monitor, and alpha-beta-gamma counter. They are particularly concerned with the control and prevention of excessive levels of radiation.

Inspectors plan and conduct programs that are designed to instruct plant employees and the general public on safety procedures and may demonstrate the use of protective equipment, devices, and clothing. Reports are prepared on the findings of inspections and the results of educational programs. Inspectors may make recommendations for work stoppage in unsafe areas or suggest the alterations in procedures if conditions should warrant a change. They may collect data, such as on areas being decontaminated, and make comparisons of intensities of contamination with comparable locations. They are also responsible for testing detection instruments against standards to ensure their accuracy.

TECHNICIANS

Because of the growing complexity of nearly every profession, the vital role of the technician has correspondingly expanded and increased in complexity. There is no generally accepted definition for the occupation of "technician." The definition is applied to both fairly simple and routine work as well as to those jobs that demand extensive scientific training and technical skills. The term as used in this handbook refers to those people whose occupations demand both the knowledge and the use of mathematical and scientific theory, positions that probably require some specialized training, and those who work directly with or as an adjunct to a professional person, such as an engineer or scientist.

Technician jobs are only slightly more limited than those of related professional jobs. Technicians are involved in the application of knowledge and theories and frequently must analyze or solve problems using a variety of methods and equipment. Some must have skills or training in the preparation of drawings or sketches. But in general, they apply procedures or tests designed by others. Most (seven out of ten) are employed by private industry. In 1968 the federal government employed over 80,000 engineering and science technicians. State and local governments are the next largest employers, with universities employing the remainder.

In general, one to three years of post-secondary schooling is needed to qualify for entry-level positions in this field. The length of time and sophistication of training is dependent upon the requirements and complexity of a specific occupation. Candidates for technical occupations can find courses through technical colleges, vocational schools, military service training, or junior or community colleges. Many engineering, mathematics, and science students, who have not completed college degree requirements, can qualify for entry-level positions.

In recent years technician occupations have been one of the fastest growing in the United States, and it is estimated the need will continue. The demand will be strongest for those with post-secondary school training in life science, engineering, draftsman, and physical science fields.

There are many variables which apply to the salaries paid to technicians: technical specialty, amount of education and experience, type of firm for which the technician works, and the geographic location of the job. According to the BLS survey of 1968, beginning science and engineering technicians received $4,600, $5,145, or $5,732, dependent upon the above variables. In private industry the annual average salary was $9,800, and nearly one-quarter of the workers had salaries of more than $10,500.

Biological Technician (biochemical, marine life, botanical, pathological, ornithological)

The biological technician assists the biologist in analyzing and studying plants, animal and human tissues, microorganisms, and water-borne organisms. He may use chemical and microbiological equipment and techniques to study life cycles or may breed organisms for study. He is concerned with the origins, behavior, and diseases of parasites, viruses, molds, fungi, bacteria, and other organisms. He also studies the organism's natural environment and its resulting relationships to changes or effects.

The biological technician may specialize in the study of environmental pollutants on living organisms. The chemical pollutants found in the air and water, as well as noise pollution, affects the functioning of most organisms. The population explosion and the resultant impact on development of adequate and clean food and water sources add increased urgency to this kind of research and study.

The biological technician must be interested in the unexplored frontiers and untapped resources of our world. He needs superior eyesight and must possess an insatiable curiosity and a keen interest in science.

Environmental Technician (air or water pollution, sanitation, solid waste, population management)

The environmental technician utilizes various techniques, methods, and equipment to preserve and increase the purity of our environment. He is responsible for the technical work in the laboratory and field concerned with the enforcement and the monitoring of pollution standards. He is also responsible for the installation, operation, and maintenance of the equipment that is used to monitor systems and to collect samples. Environmental technicians are often responsible for collecting data and making reports, and frequently identify and recommend operational procedures or methods in developing solutions for environmental problems.

One of the most controversial, yet critical, areas in environmental careers lies in the field of population management. Technicians are needed not only in basic population research but also in the development and application of methods that aid in the management and control of the world's population growth. Work in the applied field is vitally concerned with behavior, health, and attitudes of people and the dissemination of birth control techniques and knowledge. A background in social and behavioral sciences and an aptitude for working with people are necessary criteria for selection of this occupational area.

Food Technician (food-research aid, agricultural, animal, wildlife, game, fish culture, dairy production)

There are a variety of fields and activities involved in the growing, processing, and marketing of foods for more than 205 million people in the United States today. Technicians are needed in all aspects of these activities from production to inspection to preserving and packaging. There is also a need for technicians to conduct research in finding new sources of food, better production methods, more efficient use of available food resources, and the development of adequate packaging and delivery processes. Some food technicians are involved in the collection and analysis of food samples for inspection purposes. They are also concerned with flavor, nutritional content, and the visual appearance of food products. The field is so large and varied that there are positions available for all types of people.

Health Technician (industrial hygienist, health research and laboratory, X-ray)

The environmental health technician works closely with the life scientist in solving the problems of contamination and pollution in our land, water, and air. He is actively engaged in developing new ideas to solve problems in water treatment, sanitation, and industrial pollution and is particularly concerned with these problems as they pertain to the maintenance of a healthy environment. The contamination of air, water, and land is a serious source of health problems, particularly in the area of communicable diseases. Health technicians are concerned with remedial efforts to correct or eliminate environmental irritants.

The industrial hygienist technician is concerned with employee safety factors related to large industrial complexes. This can include the testing and analysis of air for toxic fumes as well as the safety conditions of industrial settings.

Laboratory and x-ray technicians are involved in research, curative diagnostic work, and the analysis of existing health conditions. People interested in these fields should like detailed work and be curious about life processes. They need to have skills in analysis and interpretation of data. The x-ray radiological technician earned salaries of between $105 to $130 per week in 1968.

Horticultural Technician (horicultural, arboricultural, landscape, nursery, pest control)

The horticultural technician works with horticulturists in seeding, growing, arranging, and selling nursery products such as plants, trees, shrubs, and turf. People living in urban areas have become increasingly aware of the need for more vegetated areas and less concrete. Trees and planted areas may assist in the reduction of noise, shield against the sun's heat, and help to maintain an environmental balance.

The horticultural technician is directly concerned with raising and caring for flowers, shrubs, and trees. He must know the growing conditions most favorable for maximum plant growth and how to maintain healthy plants. He is actively involved in physically planting, trimming, and maintaining areas such as municipal parks and ornamental gardens. Some technicians design planted areas and floral arrangements and therefore need to understand how to display products advantageously.

People interested in this field should have analytical abilities and a love for plants and flowers. Technicians primarily work indoors in nurseries, but because the work requires physical effort, it is necessary that they have good health. A background in the basic sciences with some experience in gardening or nursery work is essential to entering this type of occupation.

Land-Use Technician (surveyor; urban-, city-, land-, town-planning)

This kind of technician investigates alleged violations of land use and zoning regulations, reviews building and land-use applications to ensure conformity with applicable regulations, and sometimes reviews applications for and complaints about adherence to local or regional land-use plans. He must be able to analyze applicable statutes related to zoning and use and concisely and clearly show his findings in written form. Most of his work is light and usually involves traveling to make inspections.

The technician who specializes in urban or rural planning assists the professionals in solving problems such as street networks, industrial locations, and the proper placement of water and sewer lines in housing developments, etc. He must also be concerned with the problem of growing slum areas or urban blight. He plays a significant role in regulating land use. The efficient use of existing land as well as the provision for adequate protection for existing landowners require the determination and enforcement of zoning ordinances.

Nuclear Technician (waste, radiation, health, engineering aide)

The nuclear technician usually works as an assistant to a nuclear engineer. He may conduct tests on nuclear waste disposal methods, write reports and assist in the development of machines and equipment, or monitor the plant facilities and working environment to detect any radiation contamination. He frequently uses complex laboratory equipment in conducting experiments. Some are involved in making drawings and models of equipment under the nuclear engineer's direction.

The nuclear technician is interested in the controlled release of nuclear materials into our environment and particularly in devising and improving measurement tests. Because the development of efficient and effective methods of disposal of nuclear waste materials is vital to the environment, water pollution and atmospheric pollution are the most immediate concerns for the nuclear technician. Generally, such technicians perform their work inside a laboratory and its related nuclear plant facility.

Physical Science Technician (electronic, mathematical, astronomical, geological, geophysical, meterological, engineering, mineralogical, noise)

Physical scientists and engineers are dependent upon their technicians to help them with the application of scientific theories. They work to solve practical problems in either basic or applied research. The physical science technician is interested in the use of knowledge and theories to reduce or prevent pollution and in the conservation of natural resources; for example, the growing magnitude of environmental noise and the resultant effect upon the behavior and general health of all living organisms. The challenge to a physical science technician in this area is to devise methods that can reduce, divert, or change noise pollution.

Information on the salary levels for technicians in the physical science areas is extremely limited. A meterological technician in 1968 could expect to begin at an annual salary of $5,000 to $7,000. A mineralogical technician in that same year started at approximately $138 per week. Some conditions that caused this wide variance were the geographical location of the job, the employing firm or agency, or the particular job specialty. In general the higher salaries were for technicians working with advance research on problems of space exploration.

Resource Conservation Technician (forest, park, recreation, wildlife, soils, etc.)

The resource conservation technician assists the land management official in the performance of his overall duties. The technician generally engages in work such as collecting meterological data, working on the surveying crews, measuring trees, testing soils, monitoring and caring for wildlife. He can also be actively involved in building access roads, supervising construction sites, and maintaining recreational areas.

The primary concern of the resource conservation technician is the overall conservation of natural resources and the reduction or prevention of pollution and destructive conditions, which constitute a major part of his duties. His activities, principally outdoors, are frequently of a strenuous, manual nature; therefore, an excellent physical condition is a requirement for all persons entering these occupations.

TESTERS OR ANALYSTS

Testing and analysis is a continual process that is vital to everyone in the related environmental occupations. Some testing jobs require technically trained workers who have had several years of experience in environmental fields or allied fields. These jobs are commonly found in research and development but can also be found in the field. Some testing jobs are done by automatic equipment. Workers who feed or check the automatic test equipment often are called "test-set" or "testing-maching" operators. They frequently use complex instruments and testing devices and must compile data and keep records of the tests and analyses they perform. A tester or analyst needs good vision, perceptive skills, manual dexterity, and patience.

Educational requirements in this occupation, as in most environmental occupations, have become more demanding. This trend is expected to continue. Frequently, testers and analyzers have had one year or more of college in a scientific or engineering field, but usually have not completed course requirements for a degree. In some instances, they have been upgraded from other positions. A basic requirement of most employers is the completion of high school courses in mathematics, physics, and chemistry. It is anticipated that the growing demand for people in this field will cause vocational schools and other higher education institutions to broaden and enlarge the courses available.

The tester and analyst is found in every phase of industry and government; however, at the present time the major portion of environmental control and monitoring is done by government agencies. The majority of environmental tester and analyst positions are currently found within local, state, and federal agencies. It is also anticipated that as more environmental standards are set and enforcement of those standards are initiated, there will be an increasing demand for testers and analysts in private industry.

Pollution is but one of the environmental hazards that is expected to increase the demand for all kinds of testers and analysts. As the environmental problem continues to attract attention, the need for specialists will rise correspondingly. As those currently in this field move to higher levels of responsibility, potential channels for advancement will open up and broaden in scope. Salary ranges for testers and analysts are comparable to similar positions as inspectors and monitors.

Environment Tester or Analyst (air, water, soil)

The environmental tester or analyst is primarily concerned with the determination of air, water, or soil purity. He uses a variety of mechanical and chemical tests as well as a range of methods and procedures in the determination of the level of contamination. He is particularly concerned with the control devices used by industry and the effectiveness of these devices. The tester or analyst is generally responsible to the supervisory branch of the industry or agency. In his capacity as a tester, he prepares reports and often suggests methods to improve and maintain air, water, and soil standards.

Most of the testing and analyzing work is done inside a laboratory. The gathering of test data is performed outside. The tester or analyzer may be occasionally subjected to hazardous conditions, but in general, this is not a significant problem. He often has an opportunity to travel, and in some positions with federal agencies, he may be away from home frequently.

Mechanical Tester (test-engine evaluator, sound devices, electric motor, etc.)

The role of the test-engine evaluator overlaps that of the environmental tester in that it is concerned with the pollution of the air through the sound and emissions from engines. The test-engine evaluator assembles data collected from testing fuels and lubricants in engines. He is concerned with the analysis of engine exhaust and the resultant amount of air pollution. He uses microscopes and precision weighing and measuring devices to obtain correct and accurate information.

The automobile mechanic is probably in one of the most crucial areas of air and noise pollution control. He analyzes, tests, and repairs automobile engines in an effort to keep the mechanism safe and trouble-free. The mechanic must remain alert to the fact that a properly operating engine uses fewer resources and emits fewer pollutants.

Other test-engine evaluators are primarily concerned with the noise or sound aspect of engines. The sound tester's work is primarily performed indoors where he operates sound-detection equipment to check for defects in the engines. He looks for problems that could potentially cause defective and noisy engines. He is also concerned with the accumulative noise probabilities inherent in vehicles such as motorcycles, airplanes, and trucks. Contemporary legislation requires increased use of pollution control devices, all of which require close attention by the tester to ensure proper compliance with these laws.

V. CAREERS IN ENVIRONMENTAL APPLICATION AND OPERATION

The greatest number of employed people are presently working in careers such as those represented in this occupational category. These are semiskilled workers in the labor force who operate, maintain, and sometimes assemble machinery and equipment. Included in this category are operators, laborers, and attendants. These people hold jobs that represent a vital component in environmental occupations. They are the doers--the movers, the drivers, the builders. In general, they represent the "muscle" behind the plans for environmental improvement and conservation.

There are two general job categories in this section: operator and laborer-attendant. Because there are differences in training requirements, salary levels, places of employment, and potential advancement possibilities, these subjects are discussed in each of the general category sections.

LABORERS--ATTENDANTS

The "blue-collar" worker performs a very vital function in our economy. He is the person who transforms the ideas of scientists and the plans of the engineer into the actual production of products or services. He works in many diverse jobs in the environmental occupational field from refuse collection to fish hatchery assistant. Students who have mechanical aptitudes or those who enjoy working with their hands will most likely be interested in occupations listed in this section.

The semiskilled worker performs his duties under the supervision of an operator or supervisor. He works the mills, builds the plants, tends the wildlife, or grows the small plants in nurseries. He repairs, installs, maintains, and controls the complex machinery of such facilities as a waste disposal plant. He is the person who supports and keeps running all of the necessary equipment and services in our economy.

A worker in this category ordinarily receives on-the-job training. He is usually told specifically what to do and how to do it. He often repeats the same motions or the same functions throughout the working day. A worker can learn his responsibilities in a few days and can usually become proficient at his work in a few weeks. He must be adaptable and have the ability to learn new jobs, such as the operation of new or different machines. A worker is expected to be able to read basic instructions, safety rules, and posted signs. He usually is in a position that requires strength and good physical condition. Many positions require good eyesight and coordination.

The places of employment are varied. Both the private sector and public agencies depend upon these workers to keep the wheels of productivity moving. Close to one-third of all employed workers are in occupations related to this category. Although technological progress should cause a need for increased numbers of workers in all sectors, the occupations in this category are often entry-level positions and serve as training grounds for operators and supervisory positions. The anticipated employment growth will make a large number of job opportunities available to manual workers. In addition, an even larger number of opportunities will result from the replacement of experienced workers who die or retire. As replacements are needed and as workers move into jobs of increasing responsibilities, the opportunities for advancement will increase and broaden in scope. Greater substitution of automatic power equipment for unskilled manual labor in digging, hauling, moving, lifting, and other heavy work will create other employment openings in the operation and management of this equipment. Since technological displacement of such workers is anticipated, persons in such jobs will have brighter opportunities by taking training courses and gaining experience that can be transferrable to other types of work.

Gardener (nurseryman, forestry assistant, conservation aide, park maintenance attendant, pest controller, groundskeeper)

A worker in this field primarily engages in manual activities related to the growth of plants, park maintenance (natural and man-made), conservation work, and pest control. He maintains grounds, performing a combination of activities--cutting lawns, pruning or shaping trees and shrubs, cleaning drainage ditches, spreading fertilizer, raking and burning refuse. He may be primarily responsible for the education and control of pests and fungi and other plant diseases; or he may be primarily responsible for such maintenance work as the cleaning of paths, walkways, and roads or repairing fences, walls, and other structures. He also will be planting, thinning, and weeding nursery stock; and he may be involved in tying, wrapping, or packing plants for shipment or relocation. The work is generally accomplished outdoors and can be physically demanding.

Incinerator Plant Attendant

The incinerator plant attendant is the functional member of the incineration team. He operates the incinerator under the supervision of the foreman; provides direction and assistance for the weighing and unloading of rubbish trucks; repairs, lubricates, dismantles, and replaces inoperable machinery; and handles recording and collecting fees for incineration activities. He works both inside and out and is exposed to all climatic conditions. His work is typically strenuous and may expose him to a variety of occupational hazards.

The incinerator plant attendant is immediately responsible for the incineration process. In this capacity, he controls the actual burning with its resulting emission of pollutants. He must be aware of different incineration methods and the air pollution implications of these methods. The incineration plant attendant works in close contact with the other members of the incineration team such as supervisors, delivery men, clerical staff, etc.

Janitor (waste collector, utility man, building superintendent)

The janitor regulates, manages, and coordinates the maintenance functions of buildings and industrial complexes. His responsibilities include keeping the premises in a clean and orderly condition by emptying trash, sweeping floors, regulating heat and air-conditioning equipment, making minor repairs, and notifying the management of the need for large repairs or replacements. A janitor may be involved in routine painting, plumbing, or electrical wiring and needs to know the basic skills necessary for such functions. The work is strenuous at times; therefore, the maintenance of a good physical condition is advisable.

A janitor is in a position to control one fundamental source of solid waste pollution. He can effectively sort out those materials that can be recycled from the refuse that is not salvageable. He is also responsible for the appearance of the premises and thus can have a pronounced effect on the maintenance of an aesthetically appealing community.

Refuse Collector (garbage, trash, general refuse collection and disposal, reclamation man)

A refuse collector is active in collecting refuse usually along a designated route in urban and suburban areas. Although this is not a particularly pleasant job, it is a major one in terms of present methods used to handle solid waste material produced by our society. He collects ashes, garbage, and trash from homes, businesses, and other public and private buildings and areas. He must lift and dump heavy containers and objects into refuse collection vehicles. He must do much walking in addition to the lifting. The refuse collector is often exposed to lifting, strains, cuts, and occasionally to disease.

Collection in rural areas in somewhat the same as in urban areas, with the exception that the designated route usually is much larger, with the result that each specific area is visited less frequently. Also the collector will probably have to lift and dispose of trees, limbs, brush, and other large cumbersome objects.

Resource Developer (construction miner, quarrying personnel, timberman, logger, oil field worker)

The miner and timberman are involved in the use or development of our natural resources. They are therefore concerned with conservation and harvesting of those resources. Some miners and timbermen use explosives to remove rocks, earth, and trees for mining and milling purposes. Each must be aware of economic and natural factors in his activities and also of environmental factors in the choices of what and where to mine or to cut timber. They are involved with the hauling and storing of materials mined and the refuse and nonusable materials. Therefore, they are frequently in a position to assist conservation as well as antipollution efforts.

The work of the resource developer is mostly outdoors and is physically strenuous. Students anticipating this type of career should maintain good physical condition and enjoy working out-of-doors. Considerable walking and lifting are involved, and the resource developer can be exposed to hazardous conditions.

Wildlife Attendant (fisheryman, fish hatchery assistant, animal aide, wildlife and conservation research aide)

Under supervision, the wildlife attendant performs work in major phases of the operation of fish hatcheries, refuge parks, and animal conservation areas. He performs such activities as installing and maintaining racks and traps. He may choose, care for, transfer, and incubate the eggs of fish and birds. He also keeps records pertaining to genealogy, weight, diet, and other data for breeding purposes of wildlife. An attendant maintains and cleans the ponds, cages, and other buildings used in the care and breeding of wildlife. He may operate automobiles, trucks, tractors, pumps, loaders, and other necessary equipment. He may be active in inspecting fish, birds, or animals for general appearance as well as counting them for census and supplying the general collection data involved with habitats of living wildlife.

OPERATORS AND FOREMEN

There are a variety of occupations that deal with the application and actual operation of processes, equipment, and devices aimed at protecting or cleaning up the environment. The people who hold these occupations are usually known as operators, foremen, or controllers. They are primarily engaged in setting up, starting, adjusting, watching, and stopping machines or other equipment. Usually, they work with one kind of device or system. They need to observe any changes or variances that occur in the systems and make any required adjustments. Sometimes it is necessary to make repairs or to assist in the installation of new equipment. Operators frequently need to work with written work orders, blueprints, or instructions.

An operator of these devices or systems needs to be able to conceptualize the relationship of parts to the whole system and to understand the functioning of machines and their component parts. He may frequently supervise or direct other employees. He is involved in assigning, directing, and checking the work of his subordinates to maintain the quality of work and the plant standards of his operation.

In some specific operations, certification may be required of an operator. Usually this can be obtained from apprenticeship programs. Experience as an apprentice is frequently the entry level; and as the worker demonstrates increasing skill and a willingness to accept responsibility, he will be admitted to a journeyman position. This type of on-the-job training is excellent for operator positions. Post-secondary, vocational, or technical training is usually helpful in obtaining a job in this area. Some additional training may be required even at a journeyman level. Such training may serve as a substitute of up to two years of experience in some jobs.

Local, state, and federal agencies employ a substantial number of operators in this classification of environmental occupations. However, as contemporary legislation requires increased pollution control devices, all of which require close attention by operators to ensure proper operation, private industry will need their services at a growing rate. Also, there will be some new industries develop through the need for recycling operations. Public utility companies also hire a substantial number of employees in this field and cannot be overlooked as vital employment sources.

As with the majority of careers in the environmental field, the potential for advancement in the next decade is favorable. Numerous promotional opportunities are available to skilled workers. Many advance to foremen or to other types of supervisory positions. As private and public industries continue to use more complex machinery and equipment, opportunities for entry into these jobs and opportunities for advancement are expected to expand.

Dumps and Solid Waste Disposal Operator

The disposal of solid waste materials usually is accomplished by incineration, composting, or sanitary landfill. The people who make a profession of the disposal of solid waste materials must be cognizant of the new and more efficient methods that are now being developed. Historically, the operator of disposal materials has had to be able to operate mechanical and electrical equipment to maintain the orderly collection and processing of solid waste, and to supervise the workers who assist him. He assigned and directed the operation of trucks and organized the collection routes. An operator at these locations at the present time and in the near future will have to "sort" or redistribute waste products to various types of disposal operations. Some products may be recycled or salvaged. He also must continually be alert to the control of rodents and other pests to maintain the highest standards of sanitation possible.

Incinerator Foreman

The incinerator foreman is primarily concerned with the proper use of equipment to "burn" refuse or dry sludge accumulations. The effective handling and proper disposal of combustible rubbish are important in reducing air pollution. The foreman acts in a supervisory and advisory position in relation to incinerator operators and, in some cases, to clerical personnel. Other activities include training programs for new employees and development of advanced techniques, inspection and adjustment of machinery, and the provision of written reports on the facility's operation. The work is both indoor and out and can be physically demanding.

The incinerator foreman, who is in a position to conscientiously provide guidance that will lead to more efficient disposal of combustible rubbish with the least air, water, and land pollution, can provide leadership in the development of new techniques of incineration. He must be dedicated to the proposition that efficient burning processes must occur if air pollution is to be reduced.

Incinerator Operator (dumps, solid waste)

The incinerator operator controls the equipment that burns garbage and other refuse (such as sludge) in public or industrial incinerator plants. He directs the employees in their work of feeding the materials into the furnaces and other burning devices. He is responsible for the maintenance and correct adjustment of control devices such as meters, pyrometers, and burners to keep the temperatures constant and to obtain the most efficient combustion. Frequently, he is responsible for repairing and replacing equipment. He also regulates disposal of ashes and dumping. He sometimes is responsible for the power plant that provides energy for these operations.

Power Plant Operator (hydroelectric, fossil fuel, nuclear, stationary)

The power plant operator's role is vital in several areas of environmental control. He operates the boilers, turbines, generators, and other auxiliary equipment. He is usually responsible for supervising the equipment control device and regulates those that feed the subsystems of the power plant, including the adjustments which regulate speed, voltage, and incoming turbines to coincide with the voltage and power being generated. The power plant operator is also responsible for reporting and recording any malfunctions of the equipment, may recommend replacement of the equipment or installation of updated systems, and can be influential in instigating the use of devices to reduce atmospheric pollution. The nuclear power plant operator will be especially concerned in this area of pollution control.

Recycling Operator (salvage laborer, waste disposal worker, reclamation foreman)

Salvaging has been an active part of our economy for many years; but with the increasing emphasis upon refuse and pollution, a concerted effort has recently developed to find uses for waste and refuse products. It is anticipated that this trend will accelerate and dramatically grow in the next decade. Persons involved in salvaging and recycling efforts now will be part of the development of new and broader methods in the future.

The operator will determine the types of materials to be salvaged and direct laborers in sorting, storing, and redistributing materials to be recycled. He will inspect materials to determine exact methods of redistribution and designate, according to kind and type, the salvageable material. The operator or foreman will direct the dismantling of large objects (such as airplanes) and will inspect parts, routing reparable objects to repair shops and nonreparable objects to salvage.

Water or Sewer Systems Foreman (pure water works, purification, waste water, sewage, etc.)

The plant operator working in the water or sewer systems component of environmental careers is engaged in supervising the crew of employees that install, maintain, repair, and service the water distribution and sewage facilities. He is primarily concerned with maintaining efficient service to citizens but can also be vitally concerned with determining conformance to environmental standards and specifications. Some may be responsible for writing reports from the data they collect on work progression and disposition of materials. He may also need to evaluate systems and to determine the best methods of excavation and repairs using land plats, maps, and other diagrams.

Waste Water Treatment Plant Operator

The semiskilled area of work requires the operation and maintenance of waste water treatment plant equipment under the supervision of higher level personnel. The worker must be able to monitor system operations, read and record meters, sample the input or output materials for laboratory analysis, maintain accurate records, and in general operate various types of valves, pumps, fans, heaters, boilers, and other specialized equipment. The duties of a waste water treatment plant operator are primarily conducted indoors, and the physical demands are minimal.

This operator performs functions concerning the effective recycling of water and the removal and disposition of solid wastes. His duties are directly applicable to two of the environmental problems: water pollution and resource conservation. His activities are highly routine and closely supervised but nonetheless require considerable attention to detail if an effective process is to result.

Water Treatment Plant Operator

An operator of a water treatment plant is responsible for seeing that all assigned plant equipment is operating properly. He works closely with and under the direction of the water treatment plant supervisor. He is responsible for reading, recording, and maintaining the correct chemical balance in the water as it is processed through the plant facility. Operators must be skilled in the practice and techniques of water purification.

The water treatment plant operator performs the vital function of providing the citizenry with pure water. He also could be responsible for maintaining sufficient quantities in reserve or storage areas such as reservoirs. His activities are usually routine and closely supervised but nonetheless are vital components of our ecological system related to water.

APPENDICES

APPENDIX 2-1

ADDITIONAL SOURCES OF INFORMATION ON ENVIRONMENTAL CAREERS

Aeronautics

American Institute of Aeronautics and Astronauts, Inc.
1290 Avenue of the Americas
New York, New York 10019

Agriculture

American Society of Agricultural Engineers
P. O. Box 229
Joseph, Michigan 40985

Air Pollution

National Air Pollution Control Administration
Box 12055
Research Triangle Park, North Carolina 27709

Anthropology

American Anthropological Association
1703 New Hampshire Avenue, N.W.
Washington, D.C. 20009

Architects

American Institute of Architects
1735 New York Avenue, N.W.
Washington, D.C. 20006

American Society of Landscape Architects, Inc.
2013 I Street, N.W.
Washington, D.C. 20006

Association of College Schools of Architecture
521 18th Street, N.W.
Washington, D.C. 20006

Biology

American Institute of Biological Sciences
200 P Street, N.W.
Washington, D.C. 20036

Federation of American Societies for Experimental Biology
9650 Wisconsin Avenue
Bethesda, Maryland 20014

Chemistry

American Chemical Society
1155 16th Street, N.W.
Washington, D.C. 20036

Manufacturing Chemist's Association, Inc.
1825 Connecticut Avenue, N.W.
Washington, D.C. 20009

Conservation Education

Conservation Education Association
c/o Secretary
1144 East 3rd Street
Salt Lake City, Utah 84102

Dietetics

American Dietetic Association
620 North Michigan Avenue
Chicago, Illinois 60611

Ecology

Ecological Society of America
c/o Secretary
Radiation Ecology Section
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831

Economics

American Economic Association
Northwestern University
629 Noyes Street
Evanston, Illinois 60201

Engineers

American Institute of Chemical Engineers
345 East 47th Street
New York, New York 10017

American Institute of Industrial Engineers
345 East 47th Street
New York, New York 10017

American Society of Civil Engineers
345 East 47th Street
New York, New York 10017

American Society for Engineering Education
200 Pennsylvania Avenue, N.W.
Washington, D.C. 20037

American Society for Mechanical Engineers
345 East 47th Street
New York, New York 10017

National Society of Professional Engineers
2029 K Street, N.W.
Washington, D.C. 20006

Society of Mining Engineers of the American Institute of Mining
Metallurgical, and Petroleum Engineers
345 East 47th Street
New York, New York 10017

Fisheries Management

American Fisheries Society
1404 New York Avenue, N.W.
Washington, D.C. 20005

Forestry

U.S. Department of Agriculture
Forest Service
Washington, D.C. 20250

American Forest Institute
1835 K Street, N.W.
Washington, D.C. 20006

Society of American Foresters
1010 16th Street, N.W.
Washington, D.C. 20036

Geography

Association of American Geographers
1146 16th Street, N.W.
Washington, D.C. 20036

Geology

American Geological Institute
2201 M Street, N.W.
Washington, D.C. 20037

Geophysics

American Geophysical Union
2100 Pennsylvania Avenue, N.W.
Washington, D.C. 20037

Society of Exploration Geophysicists
P.O. Box 3098
Tulsa, Oklahoma 74101

Health

American Public Health Association, Inc.
1740 Broadway
New York, New York 10019

Institute for the Study of Health and Society
2199 North Decatur Road
Decatur, Georgia 30033

National Environmental Health Association
1600 Pennsylvania Street
Denver, Colorado 80203

National Sanitation Foundation
P.O. Box 1468
Ann Arbor, Michigan 48106

Medicine

Association of American Medical Colleges
2530 Ridge Avenue
Evanston, Illinois 60201

American Medical Association
535 North Dearborn Street
Chicago, Illinois 60610

Meteorology

American Meteorological Association
Second and B Streets, S.E.
Washington, D.C. 20032

Oceanography

American Society for Oceanography
854 Main Building
Houston, Texas 77002

American Society for Limnology and Oceanography
W. K. Kellog Biological Station
Michigan State University
Hickory Corners, Michigan 49060

International Oceanographic Foundation
1 Rickenbacker Causeway
Virginia Key
Miami, Florida 33149

Office of Environmental Sciences
Smithsonian Institution
Washington, D.C. 20560

National Oceanography Association
1900 L Street, N.W.
Washington, D.C. 20036

Outdoor Recreation and Parks

American Recreation Society
Room 622, Bond Building
1404 New York Avenue, N.W.
Washington, D.C. 20005

National Recreation Association
8 West Eighth Street
New York, New York 10011

Political Science

American Political Science Association
1527 New Hampshire Avenue, N.W.
Washington, D.C. 20036

Resource Economics

Resources of the Future, Inc.
1755 Massachusetts Avenue, N.W.
Washington, D.C. 20036

Resource Management

The Conservation Foundation
1250 Connecticut Avenue, N.W.
Washington, D.C. 20036

Sociology

American Sociological Association
1001 Connecticut Avenue, N.W.
Washington, D.C. 20036

Soil Conservation

Soil Conservation Society of America
7515 N.E. Ankeny Road
Ankeny, Iowa 50021

Statistics - Mathematics

American Statistical Association
806 15th Avenue, N.W.
Washington, D.C. 20005

Technicians

National Council of Technical Schools
1835 K Street, N.W.
Room 907
Washington, D.C. 20006

U.S. Department of Health, Education, and Welfare
Office of Education
Division of Higher Education and/or Division of
Vocational and Technical Education
Washington, D.C. 20202

Urban Planning

American Institute of Planners
917 15th Street, N.W.
Washington, D.C. 20005

American Society of Planning Officials
1313 East 60th Street
Chicago, Illinois 60637

Water Pollution

Water Pollution Control Federation
3900 Wisconsin Avenue, N.W.
Washington, D.C. 20016

Wildlife Conservation and Management

The Wildlife Society
Suite S-176
3900 Wisconsin Avenue, N.W.
Washington, D.C. 20016

National Wildlife Federation
1412 16th Street, N.W.
Washington, D.C. 20036

APPENDIX 2-2

ENVIRONMENTAL EDUCATIONAL INSTITUTIONS

The majority of career occupations that have been identified in this handbook require post-secondary education or training. These requirements vary from relatively short-term technical training leading to requisite certification, to extended professional education, and to receipt of academic degrees. For the student who is interested in furthering his career training and needs information pertaining to selection of an appropriate post-secondary school or institution, it is necessary that he obtain the most accurate data that can be made available to him. Interest in environmental problems is just beginning to coalesce, and as a result, institutional curricula programs are in a state of flux. To state that one institution provides certain types of environmental career programs and not others would probably turn out to be inaccurate information. Therefore to facilitate the student's acquisition of current and valid information, this appendix provides under four general institutional classifications resources where accurate information can be found that will guide the student to the annual catalogues published by most educational institutions.

Colleges and Universities

These schools offer academic courses and programs in subject fields on undergraduate and graduate level, for potential managers and researchers.

1. Environmental Protection Agency, Working Toward a Better Environment--Some Career Choices, Environmental Protection Agency, Washington, D.C.
2. Environmental Science and Technology "Manpower for Environmental Protection," Vol. 5, No. 4, April 1971, Environmental Science and Technology, P.O. Box 8639, Philadelphia, Pa. 19101.

3. Engineers' Council for Professional Development, Information on Careers in Engineering and Technology, 345 East 47th Street, New York.
4. National Recreation and Park Association, Directory of Professional Preparation Programs in Recreation, Parks, and Related Areas, 1969, National Recreation and Park Association, 1700 Pennsylvania Avenue, Washington, D.C. Free
5. National Wildlife Federation, Conservation Directory, 1971, National Wildlife Federation, 16th Street, N.W., Washington, D.C. $1.50
6. Randall, Charles Edgar, So You Want To Be a Forester? American Forestry Association, 1319 18th Street N.W., Washington, D.C., 20036
7. United States Department of Labor, Health Careers Guidebook, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Community Colleges (two-year or junior college)

These institutions offer on an undergraduate level both academic and technical courses (applied) for technicians and operators.

1. American Association of Junior Colleges. Membership Directory 1971-72, American Association of Junior Colleges, 1 Dupont Circle, Washington, D.C. 20036.
2. Environmental Protection Agency, Working Toward a Better Environment--Some Career Choices, Environmental Protection Agency, Washington, D.C.
3. Ferguson Publications in the Fields of Counseling, Guidance, and Personnel Services, Career Opportunities for Technicians and Specialists, Walter J. Brooking, Assistant Editor-in-Chief, J.G. Ferguson Publishing Company, Chicago, Ill., five volume reference series:

Engineering Technicians, Walter J. Brooking, editor.

Agricultural, Forestry, and Oceanographic technicians, Howard Sidney, editor.

Health Technicians, Robert E. Kessinger, editor.

Community Service and Related Specialists, editorial consultants: Sylvia J. Bayliss, Eli Cohen et. al.

Ecology, Conservation and Environment, Ferguson editorial staff.

4. Pratt, Arden L., Environmental Education in the Community College, 1971, American Association of Junior Colleges, 1 Dupont Circle, N.W., Washington, D.C. 20036.

5. United States Department of Labor, Health Careers Guidebook, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Technical Schools

They offer technical courses designed to specifically train technicians and operators.

1. National Association of Trade and Technical Schools. Directory of Accredited Private Trade and Technical Schools, 1971-72, W.A. Goddard, Ex. Director, National Association of Trade and Technical Schools, 2021 L Street, N.W., Washington, D.C. 20036.

2. United States Department of Labor, Health Careers Guidebook, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Outdoor Educational Centers

This includes offerings by a variety of museums, parks, centers, etc., designed to promote education and training in conservation and natural resource development

These are basically nondegree programs; some, however, award certificates of graduation. The programs are highy job oriented.

1. National Audubon Society, Directory of Environmental Education Facilities, Nature Center Planning Division, 1130 Fifth Avenue, New York, N.Y. 10028.

APPENDIX 2-3

ESTIMATING METHODOLOGY CONCERNING JOB REQUIREMENTS FOR OCCUPATIONS RELATED TO ENVIRONMENTAL POLLUTION CONTROL PROBLEMS

This appendix is provided for those who are interested in the methodology used to arrive at the estimated expenditures for the six pollution control categories of air, water, solid waste, noise, radiation and pesticides, and the matrix determinants for translating expenditures into environmental manpower requirements.

In developing the estimates, there were the unavoidable problems of determining appropriate criteria, obtaining data, and defining matrix relationships. In particular it was recognized that defining what is and what is not an environmental problem is currently receiving a great deal of attention. However, efforts to identify with any degree of confidence or accuracy occupations that could be defined as being environmentally related lacks precision. For example, arguments can be made that can fairly closely identify a statistician who is specializing in biostatistics as having a high degree of concern for environmental problems involving biological factors. However, a statistician dealing with analysis of population characteristics can only indirectly be linked in dealing with environmental problems. The lack of precise criteria by which occupations are defined as being an environmental occupation is only part of the problem. The other is a lack of data and information on those jobs which have existed or have recently been created that are not sufficiently significant to receive classification, specification, measurement, or statistical treatment. Or, if they have been identified, little if any data are available on them.

Another problem is that of naming occupations. Several titles or occupational names exist for basically the same type of job. Hence, if one were to think that an acoustical engineer might be a job concerned with the nature of sound and noise and devising ways to control it, such a title is cross-referenced in the dictionary of occupational titles to a specialty in electronics engineering that concerns itself with the design of sound or broadcast equipment, recording equipment, and so forth. As a result of such difficulties, estimating job opportunities by attempting to project for each environmentally related occupation as listed in this handbook was not done.

Consequently, it was necessary to limit the estimated "environmental" occupations to four general categories for the aforementioned six pollution control areas. This limitation on environmental coverage is based on the availability of estimated expenditures expected to occur in those six areas. The matrix developed to allocate those expenditures is, of course, not perfect by any means. But, it has been constructed in such a way that if a given level of money were to be channeled into those six areas, one might reasonably expect certain kinds of expenditures to be made for capital acquisition, administration, and support services as well as manpower required for direct work on environmental problems. The matrix approach used does not allow the specification of single occupations. However, given the types of occupations clustered, for example, in the environmental science and research category, a general statement can be made in terms of manpower requirements for a given level of expenditures. Since some fairly good data are available on specific occupations, these have been included in Chapter 2 as Table 2-1. Not all the occupations listed in Chapter 2 appear in that table, particularly in the operator, monitor, or analyst jobs. Similarly, the occupations listed in Chapter 2, such as educators, sociologists, etc., are not reflected in the matrix by which the manpower estimates were developed for environmental occupations in six pollution control areas. As pointed out earlier, occupations that are generally in a supporting role, such as typists, janitors, data processing, etc., are not included.

All of the preceding statements point out the difficulty and complexity of obtaining useful and reliable information concerning a relatively recent development of thinking about jobs as being environmentally related. The usefulness of such information in the form of projections depends not only on some criteria for being environmentally classified, but also on the stability of occupational trends being examined. For example, about ten years ago a critical need for engineers, scientists, etc., was identified for the aerospace and missile industries. A great deal of effort was put into developing projected needs for all types of occupations related to those industries. But now those persons basing their choice of careers on such information find themselves with, say, Ph.D.s in physics and very few opportunities available in such industries. Of course, no one could foresee the course of events ten years into the future, but this points out the difficulty of using uncritical projection methods that blindly attempt to forecast the future. However, for some occupations, such as secretaries, clerks, salesmen, etc., projections of future levels of employment needs can be made with a great deal of confidence if the economic assumption on which they are based actually occurs.

Given the extremely complex and uncertain nature of the projections game, making estimates can be useful. Intelligent planning and decision making can only be done by trying to speculate about what the future will be. Some types of planning require speculation 50 years ahead, while only a year or two, sometimes a month, may be satisfactory for other types. The time horizon of 1970 to 1975 was chosen for developing estimates of environmental occupational jobs for the primary reason that most of the data required has been prepared for that time period. Another reason was that it represents a fairly short period of time, which is not too far into the future (1975) and for which current events can be relatively easily assessed in terms of data availability (1970).

In defining the problem, it was recognized that environmental occupations lack the framework of being defined by an industry, such as mining, construction, or manufacturing. Thus, many of the parts of what could be thought of as the "ecology" industry are actually extensions of other industries. Consequently, the more traditional methods of estimating occupational requirements and growth were not adaptable to projecting the occupational needs of the ecology industry. However, given the availability of expenditure data classified by pollution control programs based upon meeting environmental standards by 1975, it was considered possible to build a model by which dollar expenditures could be converted into manpower requirements.

The estimating methodology is primarily based upon knowledge and information of other industry characteristics and structure and translating them into what might be required by "ecology" operations, such as plant and equipment, operating costs, wages and salaries, capital-labor ratios, etc. The following discussion presents how the data were developed and used in the estimating methodology:

1. The expenditure of funds necessary between 1970 and 1975 to meet environmental standards on schedule, as estimated by the Council on Environmental Quality for Air, Water, and Solid Waste has been used as a base.[1] An adjustment was necessary to estimate expenditures that may occur regarding noise, radiation, and pesticide pollution control. Expenditure data

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[1] Second Annual Report, CEQ, 1971, p. 117. The expenditure estimates developed by CEQ have their own assumptions and qualifications which are recognized in using such estimates for the purposes of the allocation matrix.

used to develop Manpower requirements by the area of environmental pollution control is shown in the following table.

Estimated Pollution Control Expenditures
(Data in Millions of Dollars)

Pollution Control Category	1970		1975		Cum. 1970-1975	
	Total Expend.	Estimated Wages	Total Expend.	Estimated Wages	Total Expend.	Estimated Wages
Air	$ 500.0[a]	$ 285.0	$ 4,700.0[a]	$ 2,707.5	$ 23,700.0[a]	$ 7,481.2
Water	3,100.0[a]	1,651.2	5,800.0[a]	3,093.7	38,000.0[a]	11,862.2
Solid waste	9,300.0[a]	3,864.0	7,800.0[a]	5,313.3	43,500.0[a]	22,943.2
Noise[b]	400.0	278.2	960.0	685.7	3,400.0	2,409.8
Radiation[b]	1,300.0	764.4	1,430.0	840.8	6,800.0	4,013.0
Pesticides[b]	300.0	174.4	1,050.0	610.5	3,400.0	1,962.2
Total	$14,900.0	$6,917.2	$21,740.0	$13,251.5	$118,800.0	$50,671.6

[a] Second Annual Report, CEQ, 1971, Table 2, p. 111.

[b] Total expenditure estimates based on adjustment of governmental budget data for noise, radiation, and pesticides contained in Appendix K, Second Annual Report, CEQ, Table 0-3, p. 341.

2. Three general functional areas were defined as: research and development, (R & D), operations and processing, and enforcement. These general functions were distributed against each of the six pollution control areas as to their percentage of expenditure importance. These are shown in the following table:

Estimated Percentage Distribution of Expenditures by
Pollution Category and Function

	Air	Water	Solid Waste	Noise	Radiation	Pesticide
R & D	50	20	40	80	75	40
Processing and operation	25	45	60	0	15	40
Enforcement	25	35	0	20	10	20
Total	100	100	100	100	100	100

3. The next step was to remove associated plant and equipment costs and operating costs from allocations for each pollutant for each activity. For air, water, and solid pollutants, this was essentially done in the CEQ study. For noise, radiation, and pesticides, the following distribution was used:

Estimated Percentage Reduction for Capital
and Nonwage Costs

	Air	Water	Solid Waste	Noise	Radiation	Pesticide
R & D	05	05	05	05	05	05
Processing and operation	82	36	17	NA	128	40
Enforcement	12	12	NA	12	12	12

NA=not applicable.

In the preceding table, the R & D and the enforcement categories were held essentially the same in terms of plant and equipment costs between pollutant categories. This was necessary primarily because of time constraints and a lack of information as to the relative importance of experimental equipment between pollutant categories, or operational problems for R & D and enforcement. For processing, the pollution categories except noise were compared against a series of equipment costs to operations believed similar; for example, air was ranked with petroleum in technology, automation, and labor requirements. Radiation was considered to have equipment costs far beyond any available industry data. No information was available that could be comparable to noise pollution problems. The following table shows the relationships of manufacturing industries between labor costs and equipment costs.

Capital-Labor Ratios for Selected Industries and
Estimated C/L Ratios for Pollution Categories

Manufacturing Industries	Labor & Equipment Costs
Apparel and related products	.0380
Leathergoods	.0411
Miscellaneous manufacturing	.0704
Furniture and fixtures	.0890
Printing and publishing	.1101
Electrical equipment and supplies	.1190
Fabricated metal	.1193
Transportation equipment and supplies	.1204
Machinery, except electrical	.1328
Instruments and related	.1395
Tobacco products	.1410
Lumber and wood products	.1532
Textile mill products	.1677
Food and kindred	.1714
Solid waste	.1700
Operating Manufacturing Establishments	.1734
Rubber and plastics production	.2062
Stone, clay, and glass products	.2269

Manufacturing Industries	Labor & Equipment Costs
Primary metal	.3082
Paper and allied products	.3586
Water	.3600
Pesticides	.4000
Chemicals	.4425
Petroleum Products	.8232
Air	.8200
Men's and women's outerwear	.0246
Footwear	.0270
Radiation	1.2800
Industrial chemicals	.6498
Petroleum refining	.9907

4. Operational costs other than direct wages were also deducted from the estimated total expenditures. The deduction rates were set at 25 percent for R & D functions, 35 percent for processing, and 30 percent for enforcement.

5. Occupational distributions for each of the three functional areas of R & D, operations, and processing and enforcement were developed from data available from Industry, Bureau of Labor Statistics, U.S. Census of Population, and from Employment Security. The distribution of resulting occupations were then regrouped into the four general environmental occupational categories, making a reduction for support personnel common to most industries (such as secretaries, clerks, etc.)

The results of this distribution are shown in the following table:

Percentage Distribution of Environmental Occupational Categories and Support Personnel by Selected Areas of Pollution Control[a]

Environmental Occupational Category	Air	Water	Solid Waste	Noise	Radiation	Pesticides
I. Science and Research	13.50	9.30	10.40	18.00	16.60	11.60

Table cont.

Environmental Occupational Category	Air	Water	Solid Waste	Noise	Radiation	Pesticides
II. Technology and Education	29.75	20.05	23.40	40.00	37.10	25.60
III. Technology Implementation	28.25	34,45	27.20	22.60	22.35	29.40
IV. Equipment Operation	17.00	26.30	28.60	6.20	11.25	22.60
V. Support Personnel Occupations	11.50	9.90	10.40	13.20	12.70	10.80
Total	100.00	100.00	100.00	100.00	100.00	100.00

[a] The table presents the percentage distribution for five occupational areas. Category V was excluded in the final computations and the remaining distributions forced to 100 percent.

Of these five occupational categories, the fifth was excluded from the environmental occupational requirements since it contained occupations that were not directly associated but represented a general need of all industries (such as secretaries, clerks, etc.).

Because the major environmental occupational categories are not definitionally the same as standard occupational classification systems currently in use, a matrix system shown below was used to convert them from the DOT.

R & D DOT Codes

	Total	Professional	Clerical	Service	Operational
Total	100	72	27	1	
I	20	20			
II	45	45			
III	17	7	10		
IV	4				
V	14		13	1	

Operation and Processing
DOT Codes

	Total	Professional	Clerical	Service	Operational
Total	100	14	11	2	73
I	4	4			
II	9	9			
III	34	1	4		29
IV	45		7		43
V	8		5	2	1

Enforcement DOT Codes

	Total	Professional	Clerical	Service	Operational
Total	100	32	20	33	15
I	10	10			
II	20	20			
III	45	2	10	33	
IV	15		5		10
V	10		5		5

Through this conversion, it was possible to use occupational distributions data on establishments and industries on a DOT classification basis. This conversion was necessary to obtain some idea of the classes or types of skills or occupations required by the various kinds of activities, such as enforcement, R & D, or processing and operations. This is because enforcement activities have a different set of skill requirements than does a Research and Development operation or the processing of solid waste.

Since there are many occupational distributions available for selected kinds of processes, there was some concern as to what distribution would be most appropriate. However, the relative broadness of the five occupational categories required considerably less specificity than if 10 or more categories had been used.

5. Average wage level assumptions were based on BLS area wage surveys, hours and earnings series, survey of scientists and professionals, census data, and others. This was necessary to arrive at an average annual wage figure for each of the four occupational categories in order to translate expenditure data into jobs. The wage levels developed for the four categories are as follows:

Category	Average Annual Wage[2]
Science and research	$15,000
Technology and education	10,000
Technology implementation	7,000
Equipment operation	5,000

The wage data was adjusted from the 1961 BLS survey of 1968 to reflect 1970 levels. The remaining computations concerning wage estimates were adjusted out in terms of the 1970 current dollar figures.

6. It was assumed that time staging problems involving R & D facility investment, hiring, training and operation levels would occur on a uniform basis throughout the period from 1970 to 1975. Although this assumption is not the way in which projects occur, it was necessary in view of the limited data available. More precisely, the estimated environmental job requirements were determined for 1970 to 1975, given the estimates of funds. The interpolation between those two points is on an average annual basis. No attempt was made to allow for varying growth rates by the occupational cells between 1970 and 1975.

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[2] Annual wage level for support personnel was estimated at $14,000, and the amount of funds required for such personnel were deducted from the total for wages to arrive at the remainder to be distributed across the four major categories.

Chapter 3

ENVIRONMENTAL EDUCATION CURRICULUM

Two Secondary School Courses

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INTRODUCTION

This chapter contains two courses designed in the unifying concept of environmental education. One is a three-week, self-contained unit focusing on environmental awareness and pollution. Complete lesson guides, a teacher's manual, and student readings are provided. The other is a semester-length course which provides breadth and depth to the study of the natural physical world, natural resources, and contemporary social problems having environmental overtones, particularly those which cause environmental deterioration. Concept formation and problem-solving leading to solutions involving individual and community action and the possiblity of vocational involvement are the underlying features of both the three-week unit and the semester course.

I. ENVIRONMENTAL STUDIES: A 15-DAY UNIT

This three-week unit is a self-contained program in environmental education designed to be inserted into existing social science or life science courses. Teachers can directly implement this unit into their existing course curricula as a ready-made plan, it can be used as a source guide, or it can be used as a model for creating similar units.

The primary focus of this unit concerns man's pollution of the natural environment, with stress also given to general environmental awareness, proper natural resource management, and individual and community involvement. Objectives of this unit include student understanding of man's unique place in nature; an understanding of the combined forces which have led to our present environmental crisis, highlighted by wanton destruction and depletion of resources, excessive pollution and poor urban planning; a quest for student participation in our national search for a healthy, safe, and balanced environment; and finally, an introduction to occupations in environmental careers.

The methods which can be employed to reach these objectives include scholastic reading (each day's subject has readings which should be duplicated and handed out to the students), classroom discussion of these readings with supplementary lectures given by the instructor, slide-tape program viewing, outdoor activities, and student participation in assigned or chosen projects.

Each day's lesson plan focuses on one particular problem relating to the overall subject. The material given will usually be sufficient to sustain the class; however, depending upon the level of student participation and the manner in which it is presented by the instructor, individual daily subjects may prove either too broad to cover in one day or too narrow. This unit is flexible, and teachers can add or delete assignments or suggestions to coincide with their individual preferences. Teachers are reminded to carry each topic and the discussion relating to it to a profitable conclusion before embarking on another topic. This unit was designed with the "average" high school student in mind and thus may not include enough material to sustain an accelerated class a full three weeks; and it most likely contains too much material to cover in that time span for a slower class. Individual teachers will have to make adjustments themselves in this unit to cover problems of this nature.

This entire unit has been favorably tested in the Salt Lake School District, Salt Lake City, Utah. This final unit reflects and incorporates modifications (both major and minor) which are designed to eliminate all problems in the original unit discovered during the extensive test and evaluation period. Some specific suggestions not detailed in the daily lesson plans include allowing in-class time for students to work on developing methods, conducting research, or performing tasks relating to their special unit assignments or projects; in-class time devoted to reading the topic essays, inviting special guest lecturers to lend expertise on particular subjects; and the need to relate the general concepts covered on the national level to specific ones in the community in which this unit is to be taught.

Distributing the assigned readings to the students may be a problem. It is recommended that the articles be mimeographed and either bound together with a durable cover (using a three-hole punch and allowing the students to put the readings inside their notebooks will accomplish this) and distributed at the start of the unit, or given out separately on a day-to-day basis to eliminate their loss.

On days when the primary lesson calls for either a presentation of a slide-tape show or an outdoor activity, alternative plans have been included to eliminate any problems relating to school finance, delays, inclement weather, or teacher preference.

The topic for the second day of this unit, "Man and the Environment," may or may not sustain the class for the entire class period. No matter how profitable the in-class discussion may be, teachers of this unit must allow time to make assignments or allow for student choice of projects due later on in the unit. Many of these assignments and reports require considerable time to complete; and if the teacher desires their completion by a specific day to cover a particular subject, it is imperative that these assignments be given at the start of the unit.

A final examination for this unit has been designed and included herein. It is believed, however, by the creators of this unit that this sample test should not be actually used to examine student knowledge, awareness, or problem-solving techniques. Each teacher can use this examination as a model but must design his own test which incorporates facts and problems from his own community and which examines the concepts and information actually discussed in the classroom, not just those drawn from the student readings or proposed discussion topics.

Teachers using this unit are reminded that they may need to use additional sources of information to supplement that gleaned from the student readings. For a complete listing of available environmental source material, consult the bibliography in chapter 4 of this handbook. Additional charts, graphs, pictures, and cartoons, as well as textbooks, can and should be collected and used when needed during the presentation of this unit.

Teachers are reminded that they may need to receive special permission from their administration to conduct the proposed outdoor activities and some of the classroom ones (particularly on Days 7 through 9). Early in this unit arrangements must be made with the school's vocational counselor to give a speech on environmental careers.

Finally, teachers using this unit are reminded that to be effective, each major discussion topic (population, air pollution, solid waste management, etc.) must be related to conditions which presently exist in their local communities. Most of the ideas and concepts detailed in the teacher's manuals are merely suggestions on how a topic might be discussed. Each teacher should only use these topics, and in particular the phraseology, as it applies to his local situation and classroom. It is recommended that before this or any other similar unit is actually introduced into the classroom, the teacher must thoroughly review the entire package of material and adapt the unit to meet the teacher's, the students,' and the community's wants and interests in this field.

Two readings follow in the appendices (designed specifically for the teacher) that give extra insight into environmental education, environmental ethics, and the need for ecological understanding. They can be used as student readings if the teacher so desires.

Environmental Studies: Unit Outline

By Day

1. The State of Our Environment
2. Man and the Environment
3. Water: The Environmental Challenge
4. Water: The Dirty Life-giving Resource
5. Air Pollution: The Problem and Risks
6. Air Pollution: Can It be Controlled
7. The Environmental Effects of Solid Wastes
8. A Field Trip to Clean up the Environment; (alternative) The Use of Land
9. Depletion of Natural Resources
10. Contaminants and Wildlife
11. A Nature Walk; (alternative) Population Problems
12. Urban Environmental Problems
13. Man--An Endangered Species
14. What Is Being Done
15. Manpower Solutions to Environmental Problems.

By Subject

I Environmental Systems

- A. Present conditions
- B. Natural systems and forces
- C. Pollution problems
- D. Resource management

II Natural Resources

A. Water--cycles, use, and pollution

B. Air--cycle, composition, and pollution

C. Land--distribution, consumption, and depletion of minerals, fuels, and forest products

III Modern Environmental Problems

A. Population

B. Contaminants--pesticides and dangerous minerals

C. Noise pollution

D. Crowding problems

E. Technological problems

F. Solid waste disposal

IV Environmental Solutions

A. Pollution abatement and control

B. Individual and community involvement

C. Manpower requirements.

TEACHER'S MANUAL

Day 1: "The State of the Environment" (Slide-Tape Show)

Knowledge Objectives:

To know that man is wantonly destroying Earth's natural resources

To know that our natural resources, including air, water, land, minerals, and metals, are limited

To know that man is part of the ecosystem and can work with the environment as well as destroy it

Skill and Attitude Objectives:

To be able to identify at least five major environmental problems shown in the filmstrip (water pollution, air pollution, solid waste, resource depletion, and noise pollution)

To become aware of the seriousness of the environmental threats to our lives, as well as the existence of mankind, by asking what can be done about these problems

Materials: Filmstrip, "The State of the Environment"; script booklet; chapter 1 text from this handbook, "Environmental Awareness"

Equipment: Slide projector; tape recorder

Method:

Begin the class by showing the filmstrip without any introduction, except requesting the students to identify and write down at least five serious problems shown in the filmstrip which affect them. After completing the filmstrip, have a student write the problems identified by the rest of the class on the blackboard. Then have the students rate the problems listed in the slide-tape show from the most serious problem to the least serious. A teacher could also have a student rate what our major environmental problems are. Have the students give reasons for their decisions.

A teacher might ask the class questions similar to the following:

(1) Why is Earth's supply of fresh water limited?
(2) What could happen if the pollutants in the air poison the present atmospheric state and seriously affect plant or animal life, reflect heat (the albedo effect or trap heat (the greenhouse effect), or in any way change the climate?
(3) Can our mineral resources last forever? What are the levels of consumption? To what use do we put minerals and fuels?
(4) How does our consumer society add to the pollution problem?
(5) List the amount of waste produced in one year in the United States and discuss the problem posed by the statistics. (The national average of solid waste in the United States is 3-1/2 pounds per capita per day.)
    (a) 360 million tons of garbage
    (b) 48 billion cans
    (c) 26 billion bottles and jars
    (d) 1,500 million tons of solid waste
    (e) 143 million tons of air pollutants
    (f) 50 billion gallons of liquid sewage.
(6) List the ways man affects nature.
(7) What is man's relationship to the environment?
(8) How can man help the environment?

Additional or Alternative Method

For the school which does not purchase the slide-tape shows, chapter 1 of this handbook, "The State of our Environment," could be incorporated into the first day's lesson. The teacher could either hand this out the previous week and discuss the major points covered in class, or could hand it out the first day and allow in-class reading. If he should use the three slide-tape shows in this plan, chapter 1 could still be used as a warm-up reading to give the students some background on the overall subject. The same objectives and methods would apply either way. A teacher may also want to allow the students to read and then discuss the ideas which appear in the readings inserted specifically for the instructor, Rene Dubos' "The Biosphere," and Ron Eber's "An Environmental Ethic." These articles appear in the appendix to this chapter.

TEACHER'S MANUAL

Day 2: Man and the Environment (Discussion of Reading)

Objectives:

To know that the bioshpere (that area on Earth which supports life) is continually evolving

To know that all earthly resources used by man are in short supply, and many are nonrenewable

To assign individuals and groups special projects relating to this unit

Materials: Reading

Method:

Begin by continuing yesterday's discussion on the state of the environment. Relate the ideas discussed involving environmental deterioration to the prime cause for that deterioration--man. Discuss the major geological features of Earth (the lithosphere, the hydrosphere, the atmosphere, and the biosphere) and the evolution of those features. Have the students catalog the various elements and forces which Earth and its systems provide which are necessary to sustain life. List man's actions which destroy or diminish the quality of those elements and forces. Discuss with the students the possibility of a future life with some of the major natural resources missing. Discuss the necessity of maintaining a rich and complex natural environment due to ecological stability , as opposed to man's recent idea of a simple environment best exemplified by the elimination of pests and growing only one crop in certain areas. Examine the possibility of our present life style continuing with our present values intact, or with them considerably altered.

Discuss the evolution of land in your local community. Have the students identify the major environmental problems in your geographical area. Include pollution in all its states (solid, liquid, and gaseous) and forms (chemical, biological, thermal, visual, noise, radiation, etc.); control and elimination of wildlife; development, use, and depletion of all natural resources; population growth; and social problems.

Save at least 15 to 20 minutes to make assignments or to permit student choice of unit topics which will be due throughout the three weeks on particular days. Make sure each student in the group is fully aware of the scope and nature of his assignment as well as the day it is due. It is imperative that this be understood by the students, particularly the due date, as many of the following lesson plans are built around the student reports. Although by no means comprehensive, the following is a list of possible topics:

(1) Types of dangerous and long-lived pesticides
(2) Use of pesticides in our community
(3) The dangers of radiation
(4) The use of additives and preservatives in our food
(5) The use of forest products in our home, community, and nation
(6) The causes of extinction or near-extinction of selected fish, birds, and animals
(7) The transportation system in our community
(8) The prevalence of noise in our community
(9) Visual pollution in our community
(10) Social conflicts in our community
(11) Urban renewal or city planning in our community
(12) Various reports dealing with the extraction and use of minerals and fuels
(13) Evaluation studies on land development in our area
(14) Major agricultural crops in our area
(15) A study of a small, somewhat self-contained biotic community or ecosystem
(16) Grow a garden organically (this will take longer than three weeks).
(17) Plant various shrubs, trees, or such on the school's campus or on state or municipal property.
(18) Evaluation studies on the local community, state, or federal government effort to abate air, water, solid waste, pesticide, thermal, radiation, and visual or noise pollution.
(19) Identify the major air, water, or land polluters in your community and analyze the types and harm of the pollution.
(20) Analyze our community's solid waste management system as to cost; effects on health; contribution to air, water, and land pollution; handling methods, etc.

(21) Conduct local population distribution studies
(22) Show samples and pictures of pollution in various forms and collected from various sources.
(23) Analyze our community's fresh and waste water systems.
(24) Investigate the local production and development of electrical power.
(25) Identify the major technological changes which profoundly affect our lives.

The above topics may each contain subjects sufficient for several individual reports.

TEACHER'S MANUAL

Day 3: Water--The Environmental Challenge (Discussion of Reading)

Knowledge Objectives:

To know that the Earth's water supply has remained relatively constant for millions of years

To know that the water on the Earth is constantly and continuously being recycled

To know that less than 0.60 percent of the Earth's water is usable to man.

Skill Objectives:

To list the effects of man's mismanagement of water, including streams, rivers, lakes, estuaries, oceans, and underground water resources

To speculate what the future will be like if man continues to mismanage Earth's water supply

Materials: Reading; ditto handout of graphs

Method:

Begin by having the students explain all the ways they use water during the day. List their answers on the blackboard. Find out what the students would do if the city water supply were disrupted for a week. Inquire as to our dependence upon water. How well do we manage this important natural resource?

Give the students the handout showing the amount of water used in daily activities, the amount of water in men, and the growing demand for water as population increases. Point out that Earth's supply of water is limited. Inquire as to what effect the growing population will have upon the Earth's water supply? How does nature use this limited vital life-giving resource? (By recycling it. Make sure the students understand the recycling procedure.)

Analyze the remainder of the reading by discussing the following quotes in the reading. Have the students explain the significance of each of the following:

(1) "Of all our resources, we have mismanaged water the most."
(2) "We change rivers into sewers, lagoons and lakes into cesspools. And we shudder at the tens of billions of dollars that now are necessary to correct our derelictions."
(3) "We seem more likely to poison ourselves to death than die of starvation."
(4) "There could come a time when great areas of the seas are transformed into deserts ... 'Silent Springs' in the underwater world."

Ask what major effects pollution, particularly sewage, has on Earth's oceans. What is happening to Lake Erie and why? Discuss the concept of eutrophication. How much in the future can we rely upon the seas if we continue as we have in the past? Why are estuaries so important? (Be sure the students realize what an estuary is.) What are the effects of man's actions? Make a hypothesis about the future of man if he does not change his present mismanagement of water. What can you do to help preserve our water supply?

A. "Water Use in Your Home"

WATER USE IN YOUR HOME

Washing dishes	**10 Gallons**
Flushing a toilet	**3 Gallons**
A shower bath	**20 to 30 Gallons**
A tub bath	**30 to 40 Gallons**
A washing machine load	**20 to 30 Gallons**

The average person uses 20 to 80 gallons of water each day in his home. Here is a list of some normal household uses of water and the amount of water required for each.

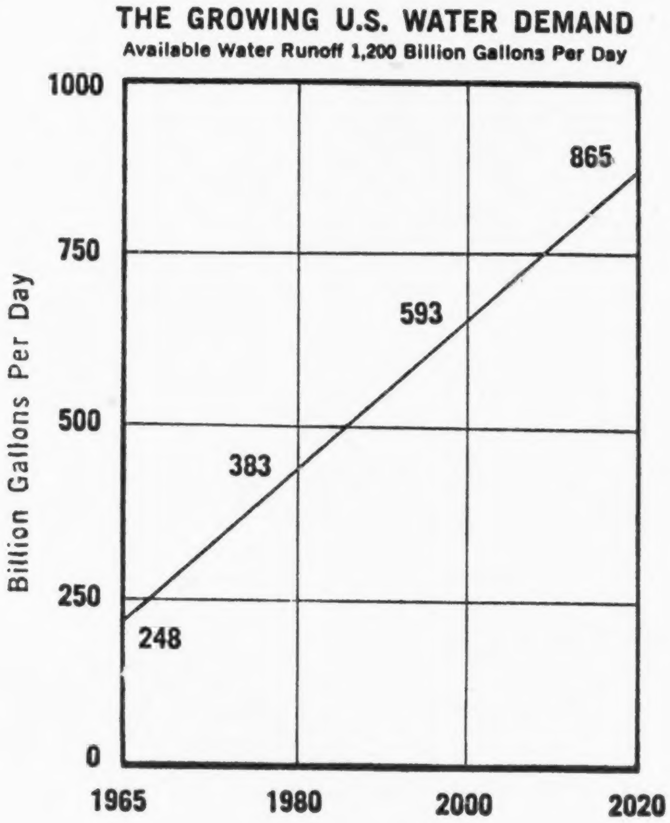
B. "The Water in Man"

THE WATER IN MAN

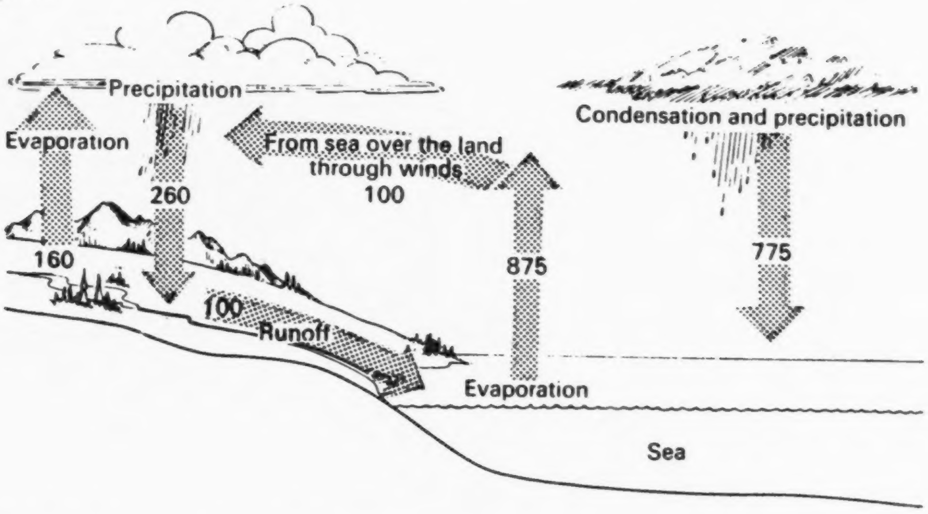
The water in the average man makes up 65 percent of his body. This water is in constant motion, moving through membranes from one part of the body to another. Water in the cells accounts for 41 percent of the body's weight. The body of the average man has about 100 pounds of water (about 50 quarts). Man replaces about two-and-a-half quarts of water a day to keep his body fluid level even.

In his lifetime, a man living to the average age of 70 will require a minimum of one-and-a-half million gallons of water.

C. "The Growing U.S. Water Demand"

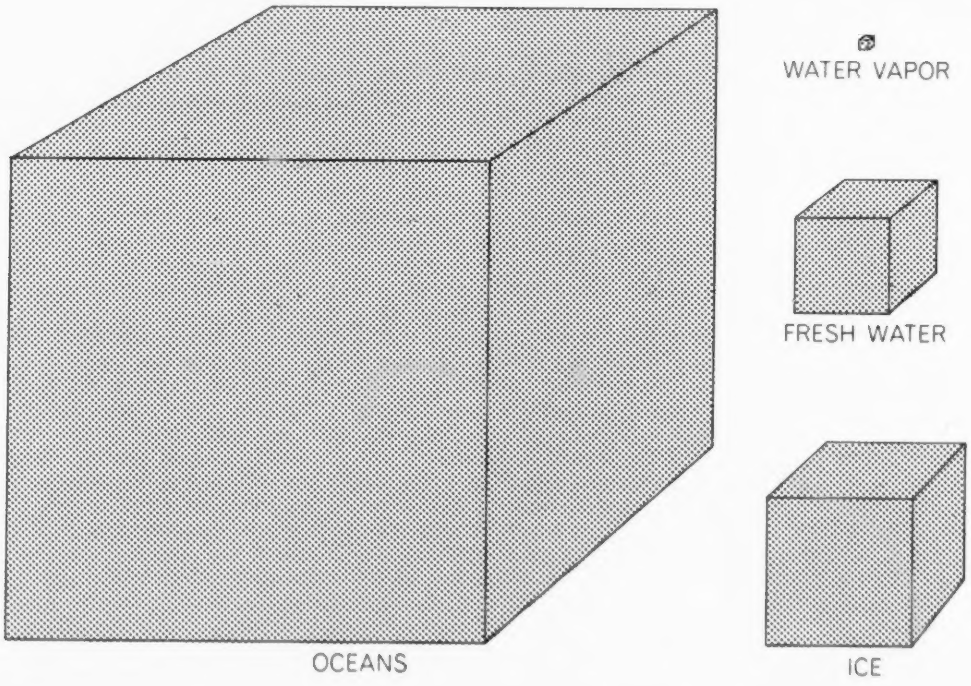


D. Water Cycle


Precipitation
Evaporation
260
From sea over the land through winds
100
160
100
Runoff
875
Evaporation
Condensation and precipitation
775
Sea

from Population Resources Environment, Ehrlich and Ehrlich, W.H. Freeman & Co. 1970. Used by permission

E. Water Supply



World water supply consists mainly of the salt water contained in the oceans. The world's fresh water comprises only about 3 percent of the total supply; three-quarters of it is locked up in the world's polar ice caps and glaciers and most of the remainder is found as ground water or in lakes. The very small amount of water in the atmosphere at any one time (top right) is nonetheless of vital importance as a major energizer of weather systems. From The Biosphere, Scientific American. 1970. Used by permission.

TEACHER'S MANUAL

Day 4: Water--The Dirty Life-Giving Resource (Classroom Project)

Knowledge Objectives:

To know ways that can help reduce water pollution

To know about some occupations and professions involved in controlling water pollution

Skill Objectives:

To speculate about the future if nothing is done to reduce and stop water pollution

To speculate about the future if something is done, and to know how to more profitably use and manage our water resources

To list different ways that each student can help reduce water pollution

To be willing to apply some of these ways to their daily lives

Materials: Job description handouts; microscope; collected samples of polluted water

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Method:

Have the students report on the assignments relating to water pollution given on Day 2. Allow each student to personally view the different specimens of polluted water that was collected under a microscope. With help from a life-science teacher, analyze each specimen for its pollution contents. (Polluted water is water which shows no normal stream or pond life in it, is generally poisonous, and lacks sufficient oxygen.) Keep samples of polluted water collected by students for display during this entire unit. Inquire about the seriousness of the water pollution problem. Examine what can happen if nothing is done about the problem. These activities will help review the materials covered in the last class period and will also allow the students to speculate about the consequences of doing nothing. Write their ideas on the blackboard and discuss them briefly.

Examine what an individual can personally do to help reduce water pollution. Divide the class into groups of five to eight students, have each group appoint a secretary to record their ideas, and have a 10 to 15 minute brainstorming session. Encourage the students to think of as many ideas as they can. Then have the secretary of each group list their ideas on the board and compile a list of activities students can do to reduce pollution. (You could have the list typed on a ditto and hand it out to the students for review purposes when you get to Day 14.)

Sample List

(1) Fix leaky faucets and toilets to conserve water.
(2) Do not run water unnecessarily, particularly when shaving, washing dishes, and car, or watering lawn.
(3) Place a brick or two in the toilet tank to reduce the amount of water used; do not flush after each use.
(4) Do not use the sink as a dump for washing down garbage, detergents, and chemicals (i.e., commercial lye products) into the sewers.
(5) Never use pesticides that can contaminate either the ground or surface water.
(6) Do not use salt in the winter to free walks of ice.
(7) Write letters to local pollutors requesting that they clean the water they use before discharging it into the local rivers, asking about their plans to reduce pollution, and expressing the students' concern about the problem.
(8) Write letters to local government officials encouraging them to enforce and strengthen water pollution laws.
(9) Do not use colored disposable paper products (i.e., toilet paper) because the dyes pollute.
(10) Do not use a dishwasher--wash the dishes yourself.
(11) Use a minimal amount of detergent.
(12) Do not constantly use your garbage disposal unit, use it sparingly.
(13) Take fewer showers and baths, and use less water when taking them.

After discussing what students can do, urge each student to pick at least five items and apply it for the duration of the course at the minimum, hopefully for life.

From the best and most practicable ideas on the list, draw up a water "Bill of Rights," outlining the proper use and maintenance of water.

Lead the discussion of eliminating water pollution to the specific subject of occupations related to water pollution. Either read or give to students the job description handouts. Ask what these suggest can be done to help reduce and stop water pollution.

Aquatic biologist
Industrial waste inspector
Power plant engineer
Sanitarian
Water purification chemist
Water treatment plant operator.

After discussing these occupations the teacher could mention other job possibilities.

If time permits, allow time for the students to write letters to government officials insisting on tighter and more far-reaching legislation, or to industrial officials who may be responsible for water pollution. Students may also wish to write to their friends, neighbors, or teachers to complain about an environmental practice relating to water pollution.

Aquatic Biologist

The aquatic biologist studies the interaction of plants and animals living in water with their environment. All conditions of this environment, i.e., water temperature, oxygen content, light, food availability, etc., are his concern. Because the delicate ecological balance can be easily upset, the aquatic biologist studies methods of achieving or maintaining the system's balance. He works both indoors and out and often spends considerable time in and around water. The physical demands of this occupation are generally light.

Environmental forces can upset the ecological balance of aquatic areas; therefore, the aquatic biologist is primarily concerned with those forms of pollution that affect this ecosystem most directly. Water and thermal pollutions are the most immediate concerns because they directly change the existing balance between and within organisms and their environments. The aquatic biologist must be aware of several other pollution forms, such as radiation and pesticides, because of their affect on food availability, water pollution, etc.

Industrial Waste Inspector

The industrial waste inspector examines waste disposal facilities in industrial and commercial facilities to determine the source of pollutants in drain sewers and municipal sewage. He must ensure that industrial and commercial facilities are licensed and that their disposal procedures are in compliance with the applicable ordinances or statutes. Based on his findings, he can issue citations to violators or recommend methods of improving the disposal procedures. Most tests of industrial wastes are conducted in a laboratory, but the industrial waste inspector can conduct field tests for acidity, alkalinity, cholorine, etc. He also uses gas-detection equipment to test for gas accumulations. The results of his investigations must be formalized in written reports. He is required to travel extensively and much of his work is done outdoors.

Adequate control of waste disposal to ensure that air and water are not polluted is of primary interest to the industrial waste inspector. He must work closely with plant managers and engineers, public officials, and law enforcement personnel to provide technical assistance and recommendations that result in more efficient waste disposal techniques.

Power Plant Engineer

The engineer who works with electricity and power has many varied and interesting opportunities available to him. He is responsible not only for the generating plant facilities, but interconnections of power systems, installation of new systems, and expansion of existing plant facilities. He supervises new construction and develops and improves plant methods. Engineers are responsible for the selection of types of fuel, design of plants, and the location of plants. They are interested and concerned about the efficient use of power and the maximization of energy generated at the power plant.

Sanitarian

The sanitarian is concerned with planning for the cleanliness and safety and the enforcement of laws concerning the handling, dispensing, and consumption of food. He plans and conducts programs related to sanitation and encouraged the enactment of regulations and laws that promote positive health standards. He works closely with other health specialists (such as public health nurses, engineers, food and drug inspectors) to prevent outbreaks of disease, and he plans for emergency situations should outbreaks of disease or natural disasters occur. Some sanitarians in large and heavily populated areas may specialize in a particular area of work, i.e., food, waste disposal, air pollution. In rural areas, they are responsible for a wide range of environmental health activities.

The sanitarian usually spends much of his time in the field. Sometimes he comes into contact with such surroundings as sewage disposal plants, refuse dumps, etc.

Water Purification Chemist

There are five branches of chemistry: inorganic, organic, analytical, physical, and biochemical. Most chemists specialize in only one branch, though the interrelationship between branches allows for a more general application. The diversity of the chemist's work defies precise description. He is concerned with the properties of matter, its composition, and its relationship when taken internally. This encompasses virtually every aspect of the universe and man. In a more pragmatic sense, he searches for knowledge about substances, and based on this and on his knowledge of transformation, he devises some practicable applications that contribute to improving our living standards. He studies, plans, organizes, writes, and discusses his research activities and results.

Most chemists work in laboratories of various types, but occasional projects require working out-of-doors. There are constant work hazards involved, but the dangers are minimized by professional competence and safety procedures.

The primary concern of the water purification chemist is the chemical composition of water, the maintenance of a high level of purity, and the recycling of waste water into usable water. The application of chemistry to environmental problems is readily apparent and well known. Specialists develop under titles such as water chemist, sewage and sanitation chemist, soil chemist, and the like; however, a more general application of chemistry to environmental problems is through research on pollution devices in industry, new and better uses for resources, etc. As industry attempts to conserve resources and in recent years reduce pollution emissions, chemists have a key role to play in both activities.

Water Treatment Plant Operator

An operator of a water treatment plant is responsible for seeing that all assigned plant equipment is operating properly. He works closely with and under the direction of the water treatment plant supervisor. He is responsible for reading, recording, and maintaining the correct chemical balance in the water as it is processed through the plant facility. Operators must be skilled in the practice and techniques of water purification.

TEACHER'S MANUAL

Day 5: Air Pollution--The Problem and the Risks (Discussion of Reading)

Knowledge Objectives:

To know the major sources of air pollution (automobiles, industry, power plants, space heating, and refuse burning)

To know the effect of air pollution on human health, vegetation, property, and the weather

Skill Objectives:

To be able to draw a picture or poster depicting a problem relating to air pollution or water pollution

To interpret a chart which shows the relationship of increasing population and air pollution with rising death rate and lung diseases

Materials:

Reading graphs to hand out

Equipment: Two open glass jars or beakers

Method:

At the beginning of class, have the students explain what they did during the past 24 hours to help reduce water pollution. Discuss the article on air pollution. The teacher may find it necessary to consult with a chemistry teacher for definitions to certain terms in this reading. Find out what contributes to air pollution. How does the automobile contribute to air pollution? What gases are the worst contaminants? Analyze the chemical composition of those gases.

At this point, give the students the two graphs on air pollution and discuss them. Discuss the sources of air pollution, and the major contaminants of the air (i.e., carbon dioxide and monoxide, nitrogen oxides, sulfur oxide, lead, rubber and asbestos particles, etc.). Ask what the relationship between bigger cities, more air pollution, and the increase in deaths is. What are the effects of air pollution on human health?

Vegetation? Animals? Property? Weather? How serious is air pollution in your city? How dirty is the air you breath? What are the major sources of air pollution in your community? To answer these questions, get two open jars of water from the drinking fountain. Put one somewhere in the classroom (e.g., windowsill of the classroom) and one outdoors. Let them remain exposed for a couple of days to serve as an air pollution index. Later, view the polluted water under a microscope to indicate how suspended air particles pollute the air.

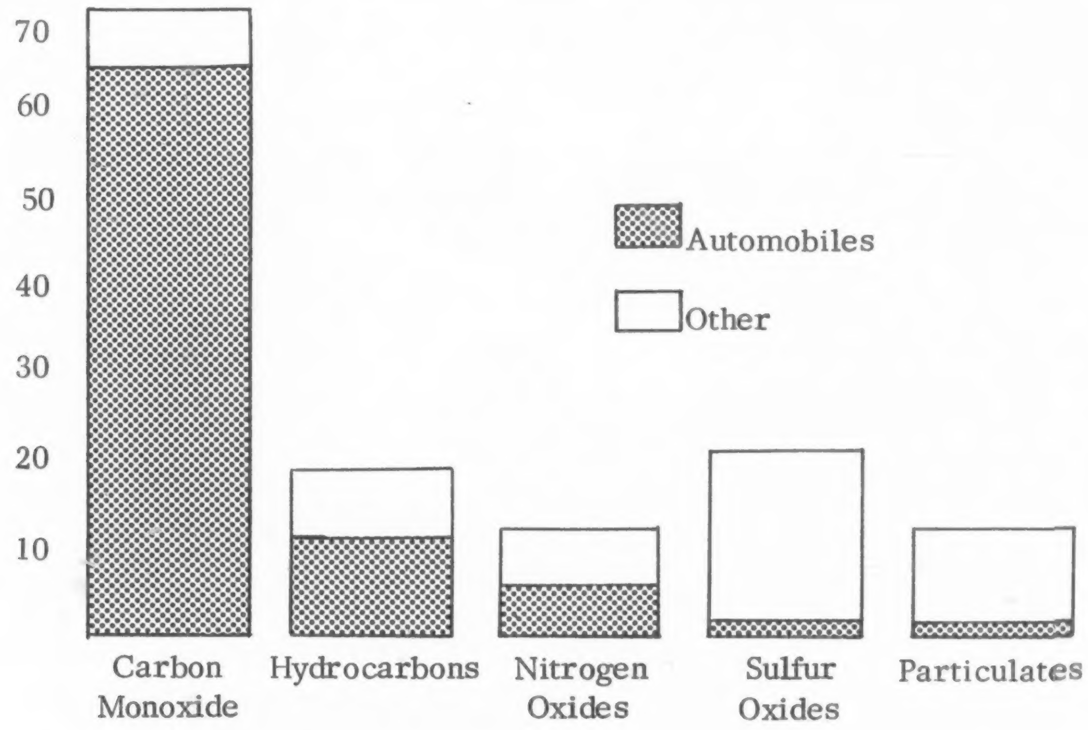
For the remainder of the class period, have the students draw posters or pictures depicting different problems relating to water or air pollution (obtain supplies from an art teacher). Discuss the students' work and put the posters on display.

Sources of Air Pollution

Source	Tons/Year	% of Total
Industry	23,000,000	16.8%
Power Plants	20,000,000	14.1%
Motor Vehicles	86,000,000	60.6%
Space Heating	8,000,000	5.6%
Refuse Disposal	5,000,000	3.5%
	142,000,000	

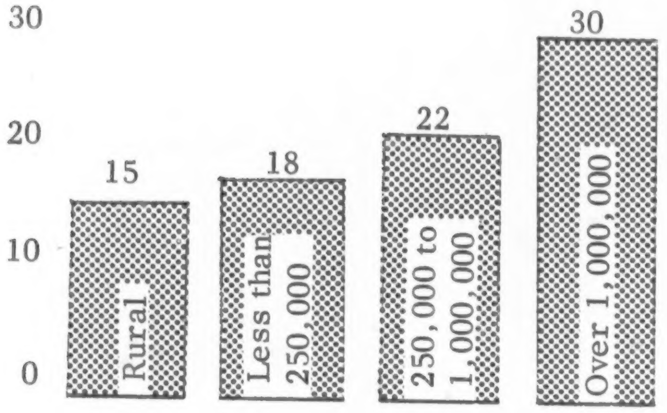
	Tons/Year
Carbon Monoxide	66,000,000
Oxides of Nitrogen	6,000,000
Hydrocarbons	12,000,000
Sulfur Oxides	1,000,000
Lead Compounds (as lead)	190,000
Particulates	1,000,000

Individual Contaminants by Source (Million Tons/Year) 1966

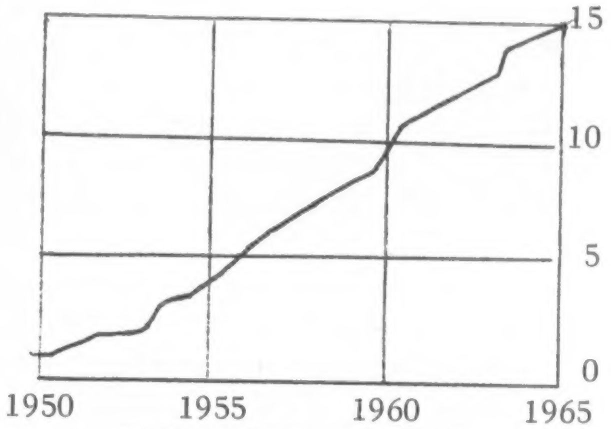


Health Hazards of Air Pollution

Bigger Cities → More Air Pollution → More Deaths

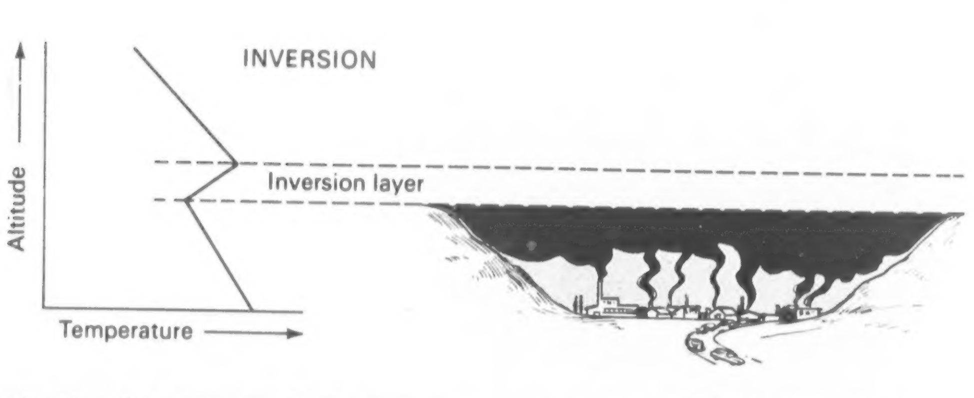


LUNG CANCER DEATHS
(per 100,000 population)



EMPHYSEMA DEATHS
(male-per 100,000 population)

Weather Occasionally Causes Air Pollution to Intensify


NO INVERSION
Altitude
Temperature
INVERSION
Altitude
Inversion layer
Temperature

from Population Resources Environment, Ehrlich and Ehrlich, W. H. Freeman & Co. 1970. Used by permission.

TEACHER'S MANUAL

Day 6: Air Pollution--Can It Be Controlled? (Classroom Reading)

Knowledge Objectives:

To know what is being done to control and reduce air pollution in the community
To know different ways that students can help reduce and control air pollution
To know the different occupations and professions involved in reducing and controlling air pollution

Skill Objectives:

To suggest ways to help reduce and control air pollution
To be willing to immediately apply at least three activities to help reduce air pollution

Materials: One glass jar or beaker; job description handouts; microscope

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Method:

Have the students report on the assignments relating to air given on Day 2. Answer any questions that are raised and discuss the reports. (Be sure to check on your school as a local source of air pollution.)

Check the air pollution index experiment jars for contaminants by comparing them with a fresh, clean jar of water. If it is difficult to see evidence of air pollution with an unaided eye, use a microscope. (Continue the experiment if you choose.) Does it show evidence of pollutants in the air? What does the evidence tell us about the air we breath? Refer to the third graph handed out yesterday. How does the experiment relate to the graph? (Students should see the relationship between air pollution and respiratory diseases.)

Divide the class into groups of five to eight students. Have each group appoint a secretary to record their ideas, and have a buzz session where the students suggest ways that they can help control and reduce air pollution. After 10 to 15 minutes, have the secretaries write the lists on the blackboard and summarize their ideas. (Ditto this list to hand out on Day 14.)

The following list contains some suggestions:

(1) Walk or ride bicycles more, rather than using the automobile.
(2) Write letters to government officials insisting on more stringent laws and law enforcement of air pollution ordinances. If there is time at the end of the class, have the students actually write the letters to government officials, local industries, automobile manufacturers, etc.
(3) Send a "Polluter of the Week" award to local industries that pollute the air.
(4) Keep your automobile properly tuned.
(5) Quit smoking.
(6) Use lead-free gasoline.
(7) Support mass transit systems by using them personally.
(8) Join a car pool for work and school.

After discussing what each student can do to reduce air pollution, urge each student to apply at least three of the ideas to their lives for the duration of the course and, hopefully, for life. Have the class design (and hopefully implement) an air "Bill of Rights."

Discuss the occupational need for air pollution control specialists. Either read or give to the students the job descriptions of: automobile mechanic, combustion engineer, and air analyst. Have one student interested in cars explain the operation and function of an automobile's pollution control valve and muffler in controlling pollutants.

Discuss how each of these occupations and devices can help reduce air pollution. Find out if any students are interested in pursuing a career involved in eliminating air pollution.

If time remains in the class period, conduct an impromtu panel discussion on air pollution by debating the principal causes. Choose seven students to sit on the panel, and assign them to assume one of the following roles: moderator, industry official, educator, student, public citizen, automobile manufacturer, government leader. Have each debate what their group wants done and what it is doing.

At the end of the class, instruct the students to bring 3-1/2 pounds of clean, dry trash (cans and bottles that have been rinsed out, newspapers, etc.) to class for the next three days. (You may need special permission from the school principal or janitorial staff to do this.) Remind the students that the 3-1/2 pounds of trash constitute each one's share of the national per capita per day litter.

Air Analyst

Air analysts are primarily concerned with the determination of air purity, using a variety of mechanical and chemical tests, and with the control devices used by industry and the effectiveness of these devices. Air analysts are generally responsible to the supervisory branch of the industry or agency and in their capacity prepare reports and suggest methods to improve and maintain the air standards. Most of the work of the air analyst is done inside. He may be occasionally subjected to hazardous environments, but in general this is not a significant problem.

The air analyst is almost exclusively concerned with air purity and the methods of achieving or maintaining this condition. Generally, he performs his duties within a confined space such as a plant or factory, but he may in some cases analyze air samples as well.

Automobile Mechanic

Automobile mechanics analyze, test, and repair automobiles in an effort to maintain them in good general condition. In a systematic manner, he inspects, adjusts, and repairs or replaces automotive parts and thereby keeps the mechanism safe and trouble-free. The work usually requires considerable stamina and physical exertion and is generally technical in nature and often requires considerable imagination if it is performed well. Working conditions are mostly indoors with occasional outdoor applications.

Automobile mechanics must remain alert to the fact that a properly operating automobile uses fewer resources and emits fewer pollutants. Contemporary legislation requires increased use of pollution control devices, all of which require close attention by the mechanic to ensure proper operation. Noise and air pollutions are, in this context, the most important areas of concern.

Combustion Engineer

The combusion engineer tests fuels, designs heating equipment that will efficiently use fuel, and tests for the result of the burning process. He attempts to determine which fuels are best suited for a specific process, hence providing optimum resource use and minimum fuel consumption. The combustion engineer works primarily indoors and obviously encounters hazards in the course of his activity. The work is not generally physically taxing.

Minimizing resource usage by an efficient burning process and a minimum level of air pollution poses a major challenge to the combustion engineer. This already specialized area of the engineering profession is unlikely to become more specialized. However, the combustion engineer must perform his basic functions cognizant of the pollution and resource conservation considerations.

TEACHER'S MANUAL

Day 7: Environmental Effects of Solid Wastes (Discussion of Reading)

Knowledge Objectives:

To know that the accumulation of solid waste is aesthetically unpleasant and physically disturbing

To know that solid waste affects human health by providing refuges for rodents and breeding places for flies, and by polluting the air, water, and land

To know that excessive accumulations of solid waste are an indication of a wasteful society

To know that the cost of cleaning up after Americans in New York City alone runs into millions of dollars, and into the hundreds of millions for the entire United States

Skill Objective:

To suggest ways that individuals can help solve this problem

Materials: Reading

Method:

Have the students explain what they did in the past 24 hours to help reduce air pollution. Put the trash the students brought somewhere in the room, preferably in a place where it gets in everyone's way. Discuss the reading by asking what general effects solid wastes have on the environment. Specifically, how does it effect the air? Water? Land? Human health? Discuss the student's feelings and emotions based upon the reading. How does the trash in the room make them feel? Discuss the creation of this trash and other in the United States. Read the testimony of John DeLury to the students and discuss the implications of his statements.

Inquire about what your community does concerning solid waste. Have the students give their reports on solid waste. Generally discuss what can be done to solve the solid waste problem. What can individuals do? If time permits, have the students suggest activities that they could do to help reduce the solid waste problem in their community. Specifically, get the students interested in consuming less and in discarding less. Discuss the concepts of recycling, disposable packaging, planned obsolescence, etc. Have the students discuss these ideas with their parents and get their reactions.

If time allows, have the students develop a "Consumers and Disposers Code" for solid products and eventual wastes (see Day 14 for suggestions). Remind the students to bring 3-1/2 pounds of clean, dry rubbish again tomorrow.

Testimony of John DeLury, President of the Uniformed Sanitationmen's Association of New York City, before a Subcommittee on Education, U.S. House of Representatives.

The faddists can always find another fad, but we sanitation men, the practical ecologists of the city streets, must stay with the almost impossible job of striving to keep the capital city of the world clean. . . .

The cities are where the people are. . . . The cities are where the air pollution is. . . . The cities are where the congestion, slums, rats, vermin, dirt, and decay are.

New York, the city I know best, cannot now cope with the pollution of its streets and its garbage problem, in spite of its budgetary allocation.

Yes, additional funds for additional manpower and equipment are clearly necessary. And yet without an educated citizenry more money won't buy the needed results.

Our city is a polluted city. The pollution of our streets is a lasting impression with which visitors leave. Is this inevitable? Is it a necessary byproduct of our size, density and congestion? Almost eight million human beings live here. They occupy 742,582 residential dwellings. Daily they are joined by another two million people coming from the suburban bedrooms around the city to make their living here.

Two million automobiles find their way into Manhattan each day.

This population, living, working, and consuming here, generates more than 10,000 tons of garbage a day. They abandon 60,000 cars on our streets which they no longer want. Our 6,000 miles of streets are, for many, their litter baskets and garbage cans.

How does the city cope? What does the administration do to prevent the people from choking on their own swill and being asphyxiated by the gas fumes of their own cars?

Three hundred fifty-three million dollars is the cost. That's the current annual budget for the Environmental Protection Administration. More than half that amount goes for sanitation services. That makes possible the daily employment of 14,000 people, of whom 10,500 are sanitation men. They are the men who go into the 6,000 miles of streets. They are the men who go into the doors of each of the 742,582 dwellings. They are the ones who collect the 10,000 tons of garbage a day, and they clean the 12,000 curb-miles in the city.

They use 3,047 trucks of all types. The cost of this equipment is $60 million.

They dispose of this waste in eight huge incinerators, four landfills, and eight marine stations, using cranes, bulldozers, 40-yard trucks, conveyors, barges, and tugs whose costs exceed $30 million.

That's the city's effort. In addition, another 2,500 tons of garbage, waste, and construction debris collected privately are disposed of by the city.

The end is not in sight. Each year sees an escalation in waste generation of 9 percent. And this is the situation throughout the country. A leading business magazine recently estimated the cost of waste removal to be $5 billion a year nationally, with a cost increase of 20 percent a year. (Forbes magazine, January 15, 1970, p. 18.)

Yes more money is needed from all sources--local, state, and federal. More capital equipment is required. But in addition, the people have a role; they can and have to help.

People, not some impersonal corporation, are the street litterers. People abandon their cars and scatter garbage on the city streets. If this pollution can be curbed at the source, then our city will be cleaner and the nation's cities will be cleaner.

TEACHER'S MANUAL

Day 8: A Field Trip to Clean up the Environment (Outdoor Activity)

Objective:
To clean up the litter around the school

Materials: Brown paper bags for every student

Method:

Have the students deposit their trash in the location designated for it in the classroom.

Ask the students if they noticed any litter and trash in their neighborhood and around the school. Find out if any was deposited by them or if they had the desire to clean it up. Tell them that today the class is going on a field trip--to clean up the litter around the school. Either go as an entire class or divide them into groups with assigned areas to clean. Have them report back to class 5 to 10 minutes before the bell rings and to bring the litter they picked up to help build up the pile of trash in the classroom. When they return, let them discuss their experiences.

Remind students to bring 3-1/2 pounds of clean, dry rubbish from home again tomorrow. Because of inclement weather or personal teacher preference, be prepared to employ the alternative plan on "Land Use" for today.

Day 8: Land Use (alternative subject) (Classroom Project)

Objectives:

To understand the broad use of land in the United States

To know the different ways in which land is used in and around your community

To speculate on the different ways in which land in your community can be put to use

To plan for urban and rural improvement by developing a model for improved land use

Materials: A map or maps showing how land is used in the United States (i.e., forests, urban areas, transportation, agriculture, grazing, etc.); a map of your community giving street plans, building locations, park sites, etc., obtained from the chamber of commerce or tax assessor

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Method:

Discuss the use of land in the United States as outlined on the attached chart. Use the classroom maps to point out land use, total areas of land in the world, and land classification. Compare the United States (which has a large percentage of land capable of productive use) with other countries which only use small percentages of their land (those with large jungles, deserts, tundra, etc.) and those which have totally developed the land; i.e. (Luxembourg, Holland, etc.).

With the maps of your local community, classify all the land within certain areas (assign different ones to different students) with regard to streets, houses, gardens, parks, industry, service, commerce, waterways, undeveloped and wilderness areas, etc. Find out both acreage and percentages involved. This assignment could be completed either with maps or through a student-conducted survey during or after school hours.

Discuss the problems of solid waste pickup and disposal in view of the multiple areas of collection. Examine each type of land use in terms of functional characteristics, aesthetic contributions, potentials for solid waste (maybe the entire structure), and needed improvements which would make the local environment prettier, healthier, or more functional.

If time allows, develop plans which an urban planner might use to redevelop your community. Attempt to provide for more open space in the form of malls, trails, recreation areas and parks, better transportation methods and systems, well distributed social institutions (schools, hospitals, churches, libraries, fire stations, shopping areas, etc.), localized industry, and a better balance between natural growth and artificial construction.

Land Use in the United States
(excluding Alaska and Hawaii)

Type of Land Use (in millions)	Acres (millions)	Percent
Forests (public, 168; private, 245; corporate, 76)	489	25.5
Grazing (public, 177; private, 223)	400	21.0
Wastelands (not in human use)	45	2.3
Farmlands (actually producing crops)	781	41.5
Military	25	1.2
National parks and recreational areas	24	1.2
Flooded (rivers, lakes, etc., excluding Great Lakes)	16	0.8
Human Use (homes, 33; roads, 53; parks, 12; industry, 26)	124	6.5
Totals	1,904	100.0

TEACHER'S MANUAL

Day 9: Depletion of Natural Resources (Discussion of Reading)

Knowledge Objectives:

To know that man is using Earth's natural resources much faster than they can be replenished

To know that the present common way of treating solid waste adds to the depletion of our natural resources

To know how recycling metals, glass, paper, etc., can help preserve Earth's natural resources

Skill Objectives:

To list the different items that contain natural resources and are found in the classroom

To devise a way to remove the trash students brought to the classroom

Materials: Trash in classroom; reading

Method:

Focus attention on the pile of trash in the classroom. How much has been collected in just three days with students bringing in 3-1/2 pounds per day (which represents the national per capita average)? How much solid waste does your classroom throw away in a week, based on the national average? A month? A year? How much waste would your school student body throw away in a year? Does this give you an idea of the problem of solid waste disposal? Have students report on local attempts to dispose of solid waste.

Repeat briefly the questioning began on Day 7 by asking the students if disposing of rubbish is the only problem caused by the waste in the classroom? What problems does disposal create with the air, water, and land? What natural resources and minerals are being thrown away? Analyze the trash in the classroom for natural resources (i.e., tin, glass, paper, wood to make the paper, trees for wood, etc.).

Discuss the reading. What is happening to the natural resources in the United States? Are Earth's natural resources limited? Why does the author call man an "ecological freak"? What is the "double dilemma" of the nation in regard to our natural resources? How can proper solid waste management help solve this dilemma? Why does the author refer to man as an endangered species? (Endangered because we are using our natural resources without much thought for the future.)

Discuss other forms of natural resources, including timber products, wildlife, land, etc. Find out what natural resources were needed to build and create the many different articles in the classroom. Have the students survey the classroom and write their answers on the blackboard (include brick walls, wood floors, metals, papers, clothes, water to make brick, etc.). How many natural resources were needed just to make the classroom? Now think of all those needed to build the school or other buildings.

Finally, pose the problem to the students of how the class is going to get rid of the trash in the classroom. (Use one of their suggestions.) Examine what recycling is and what materials can be recycled. Is there a recycling plant or organization in your community? If not, start one. (Reynolds Aluminum recycles its cans, the Coors Company recycles beer cans, glass is recycled, newspapers are recycled.) Ask how the students can help in the recycling process. Assign someone to find out about the recycling programs in your community. Pick whatever method the students choose, and dispose of the accumulated trash. Discuss how the accumulation of solid wastes is closely tied to the consumption of products. Have the students examine the products they consume and compare according to the amount of waste produced.

TEACHER'S MANUAL

Day 10: Contaminants and Wildlife (Discussion of Readings)

Knowledge Objectives:

To know that mercury pollution, pesticides, and trace metal pollution is another threat to man's health and environment.

To know that man is replacing nature with an ugly and limiting environment

Skill Objectives:

To speculate about the problems man would encounter without various forms of wildlife

To list different birds and animals whose existence is threatened by man's destruction of nature

Materials: readings

Methods:

Discuss the readings on mercury and pesticide pollution. Why are they (mercury and DDT) considered pollution problems? How can too high a concentration of them affect man? Discuss the food-chain concept. Is mercury a forewarning that other trace elements dangerous to man may be polluting our food and water supply? Is there any relationship between the life of waste mercury and pesticides like DDT? (Yes; both continue to exist, accumulate, and pollute the environment for a long time after their original uses.)

Ask the students to report on other environmental problems that they found showing how man is destroying or changing the environment. The reports could include pesticides, food additives, destruction of forests, animals and birds, destruction of cities due to overcrowding, poor planning, slicing the land with highways, traffic jams, destroying beauty with advertising means such as billboards and neon signs, etc. Ask what endangered birds and animals have in common. What are the major causes of extinction? (Direct assault, changes in environment, inability to adapt, etc.) Why are present species dying out? (Because of man's destruction of the natural habitat and man's killing them with poisons for sport and as predators.) What can be done to save them? Identify endangered species (from the master list) which inhabit your general geographical area, and examine the causes of their near extinction.

Discuss the varieties of hunting which take place in your area, listing all species hunted. Analyze the economic, ecological, and psychological reasons given by various groups to justify hunting in our industrialized society. Examine in particular the term "sportsman" when used as a synonym for hunter. The teacher might also discuss the ecological necessity for predators.

Reports on other topics could include: Should lumbering companies be allowed to cut down the timeless giant Redwood trees for profit? Should advertising companies be allowed to clutter and destroy the landscape with their signs and billboards? (For some excellent pictures showing this problem see Peter Blake, God's Own Junkyard.) Should highway builders be allowed to destroy parks and recreation areas, to divide neighborhoods and cut communities in half to build more superhighways? What is man creating to replace the solitude, the peace, and beauty of nature? What can be done about all these problems?

ENDANGERED SPECIES OF THE UNITED STATES

A species is considered endangered when it is so reduced in number or so threatened by loss of change in its habitat that it is in danger of extinction in the wild.

MAMMALS

- Hawaiian hoary bat
- Indiana bat
- Delmarva Peninsula fox squirrel
- Morro Bay kangaroo rat
- Salt marsh harvest mouse
- Eastern timber wolf
- Red wolf
- San Joaquin kit fox
- Black-footed ferret
- Florida panther
- Florida manatee (sea cow)
- Key deer
- Columbian white-tailed deer
- Sonoran pronghorn

BIRDS

- Hawaiian dark-rumped petrel
- California least tern
- Hawaiian goose (nene)
- Aleutian Canada goose
- Laysan duck
- Hawaiian duck (koloa)
- Mexican duck
- Brown pelican
- California condor
- Florida Everglade kite (snail kite)
- Hawaiian hawk (io)
- Southern bald eagle
- American peregrine falcon
- Arctic peregrine falcon
- Attwater's greater prairie chicken
- Masked bobwhite
- Whooping crane
- Yuma clapper rail
- California clapper rail
- Light-footed clapper rail
- Hawaiian gallinule
- Hawaiian coot
- Eskimo curlew
- Hawaiian stilt
- Puerto Rican plain pigeon
- Puerto Rican parrot
- Ivory-billed woodpecker
- Red-coakaded woodpecker
- Hawaiian crow (alala)
- Small Kauai thrush (puaiohi)
- Large Kauai thrush
- Molokai thrush (Olomau)
- Nilhoa millerbird
- Kauai oo (oo aa)
- Crested honeycreeper (akohekohe)
- Hawaii akepa (akepa)
- Maui akepa (akepuie)
- Oahu creeper (alauwahio)
- Molokai creeper (kakawahie)
- Akiapolaau
- Kauai akialoa
- Kauai and Maui nukupuus
- Laysan and Nihoa finches
- Ou
- Palila
- Maui parrotbill
- Bachman's warbler
- Kirtland's warbler
- Dusky seaside sparrow
- Cape Sable sparrow

REPTILES AND AMPHIBIANS

- American alligator
- Blunt-nosed leopard lizard
- San Francisco garter snake
- Puerto Rican boa
- Santa Cruz long-toed salamander
- Texas blind salamander
- Houston toad

FISHES

- Shortnose sturgeon
- Longjaw cisco
- Lahontan cutthroat trout
- Piute cutthroat trout
- Greenback cutthroat trout
- Gila trout
- Arizona (Apache) trout
- Humpback chub
- Mohave chub
- Pahranagat bonytail
- Moapa dace
- Woundfind
- Colorado River squawfish
- Kendall Warm Springs dace
- Cui-ui
- Devil's Hole pupfish
- Commanche Springs pupfish
- Tecopa pupfish
- Warm Springs pupfish
- Owens River pupfish
- Pahrump killfish
- Big Bend gambusia
- Clear Creek gambusia
- Pecos gambusia
- Unarmored threespine stickleback
- Gila topminnow
- Fountain darter
- Watercress darter
- Maryland darter
- Blue pike

TEACHER'S MANUAL

Day 11: A Nature Walk (Outdoor Activity)

Objectives:

To enjoy being close to nature

To observe the different forms of plant and animal life around the school

To observe and list the ways man has destroyed or hurt the natural environment

To realize that man is as much a part of the natural environment as the plants and animals

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Method:

Continue the student reports begun the last two days which were not finished during those class periods. Divide the students into the following three groups to make some outdoor surveys:

Group 1 should list all the birds, animals, insects, worms, spiders, etc., that they can locate near the school. They should observe the animals' relationship to nature.

Group 2 should list all the plants (and may bring carefully picked specimens) around the school. They should observe the plants' relationship to nature.

Group 3 should list the changes around the school that show how man has destroyed the natural environment or detracted from it.

Let the groups spend 30 minutes making their survey and then meet at the football field (or similar area) rather than the classroom. Have the students report the findings of their surveys.

Discuss again how man fits into the natural environment. Is he a part of nature or separate from it? Examine how dependent man is upon nature. For the remainder of the period, let the students sit or lie on the grass and enjoy a few minutes of silence in a natural atmosphere.

Because of incumbent weather or teacher preference, be prepared to employ the alternative plan, "Population Problems," for this day.

Day 11: Population Problems (alternative subject) (Discussion of Reading)

Objectives:

To know that uncontrolled population growth is a severe problem in the United States and throughout the world

To know that population pressures seriously affect natural resource depletion, cause stresses on world food production, and contribute to pollution

To speculate on the "quality of life" in the United States and throughout the world if population continues to grow at its present rates

To know various means used to control population growth

Materials: Reading; population graphs

Methods:

Discuss the reading and charts, making sure the students understand birth rates (number of live births per 1,000), death rates (number of deaths per 1,000), growth rates (birth rate minus death rate), and fertility rates (number of births per 1,000 women, ages 16 through 44).

Ask the students what the major problems associated with large populations are, considering sheer numbers and overconcentration. What national, religious, and ethnic groups support or oppose population management? What are the main methods used to control births?

Discuss the world's future, considering a population about as it is now (with 3.5 billion people), if the population should grow drastically (7 to 10 billion), or if the population should shrink (1 to 2 billion or less).

Discuss the Malthusian theory of population and food growth (population increases geometrically [1, 2, 4, 8, 16], food supplies increase arithmetically [1, 2, 3, 4, 5, 6]).

Use some handy device (matches, toothpicks, etc.) to show these progressions. This theory was originally proposed early in the 18th century and was widely criticized. Does it have any truth in it according to modern predictions and growth?

Discuss the various methods used to judge the life quality of the people (the GNP, the NNA, etc.).

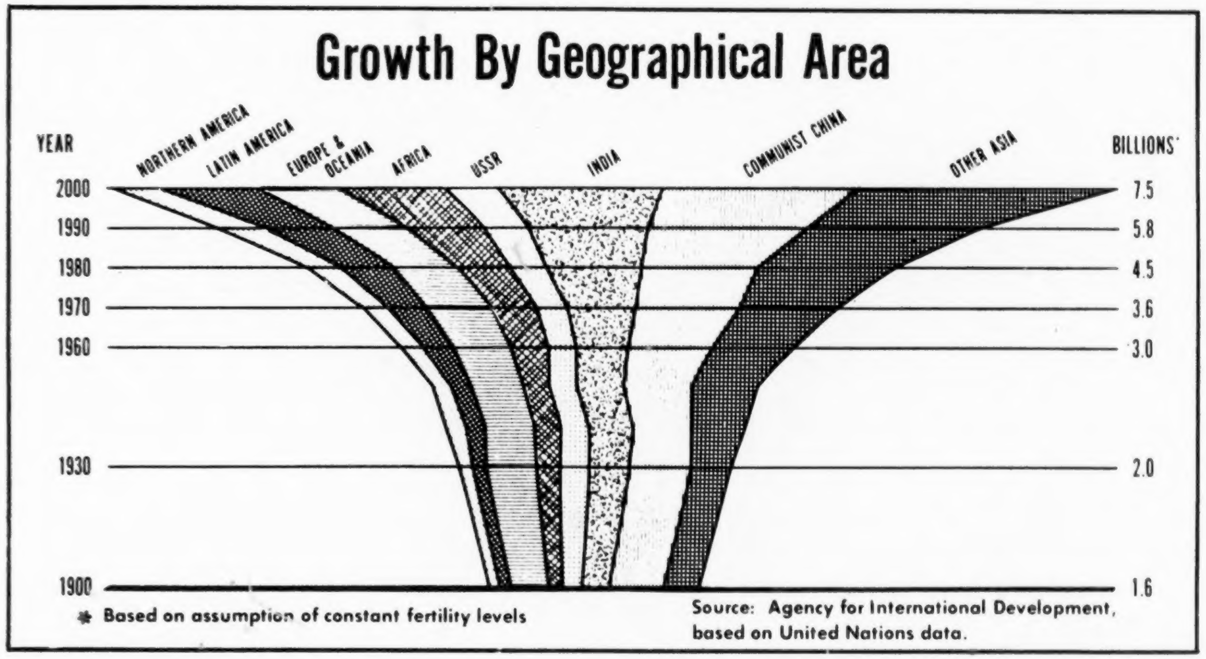
If time allows, conduct an in-class survey on the size of the students' existing families, the proposed sizes of their future families, and the environmental cost of each added birth to their communities.

THE POPULATION BOMB

In the Year 2000: Where the People Will Be

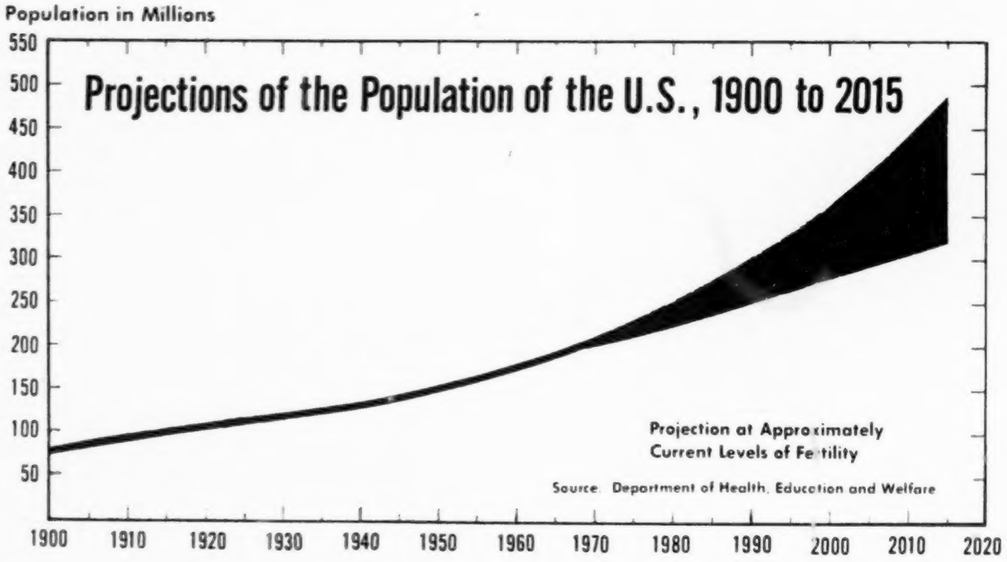
	Millions 1969*	Millions 2000
Northern America	226	388
(United States)	(204)	(350)
Latin America	275	756
Europe	456	571
Oceania	18	32
Africa	338	860
U.S.S.R.	248	402
India	542	1,259
Communist China	755	1,500
Other Asian countries	714	1,754
	3,572	7,522

*Preliminary


Growth By Geographical Area

* Based on assumption of constant fertility levels

Source: Agency for International Development, based on United Nations data.


Projections of the Population of the U.S., 1900 to 2015

Source: Department of Health, Education and Welfare

Within 70 years world population has more than doubled and is expected to double again by the end of the century. U.S. population, a little over 200 million in 1970, is expected to reach between 280 million and 370 million by the year 2000.

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Population Estimates According to U.N. "Constant Fertility, No Migration," 1960-2000, in Major Areas and Regions of the World
(Population in thousands)

Major areas and regions	*1960*	*1965*	*1970*	*1975*	*1980*	*1985*	*1990*	*1995*	*2000*
WORLD TOTAL	2,998,180	3,297,482	3,640,970	4,042,761	4,519,146	5,088,112	5,763,577	6,564,584	7,522,218
More developed regions[a]	976,414	1,037,209	1,100,340	1,168,202	1,241,660	1,319,857	1,401,980	1,488,187	1,580,049
Less developed regions[b]	2,021,766	2,260,273	2,540,630	2,874,559	3,277,486	3,768,255	4,361,597	5,076,397	5,942,169
A. *East Asia*	794,144	863,258	942,256	1,034,364	1,142,609	1,272,236	1,424,527	1,601,016	1,810,678
1. Mainland region	654,181	711,000	776,000	852,000	942,000	1,051,000	1,180,000	1,330,000	1,509,000
2. Japan	93,210	98,011	103,341	108,861	114,055	118,457	121,948	124,809	127,160
3. Other East Asia	46,753	54,247	62,915	73,503	86,554	102,779	122,579	146,207	174,518
B. *South Asia*	865,247	975,940	1,105,563	1,259,456	1,446,153	1,674,235	1,952,050	2,290,246	2,701,865
4. Middle South Asia	587,277	660,148	746,062	848,430	972,506	1,123,880	1,308,534	1,534,394	1,811,220
5. South-East Asia	218,866	248,641	282,523	322,149	370,409	430,006	502,966	590,983	696,620
6. South-West Asia	59,104	67,151	76,978	88,877	103,238	120,349	140,550	164,869	194,025
C. *Europe*	424,657	442,416	460,136	478,209	496,448	514,820	533,108	551,655	570,785
7. Western Europe	134,536	139,157	143,583	148,036	152,284	156,621	161,183	166,123	171,520
8. Southern Europe	117,488	123,273	129,224	135,221	141,304	147,498	153,492	159,291	164,962
9. Eastern Europe	96,852	101,654	106,234	111,105	116,313	121,475	126,498	131,411	136,213
10. Northern Europe	75,781	78,332	81,095	83,847	86,547	89,226	91,935	94,830	98,090
D. 11. USSR	*214,400*	*233,411*	*252,498*	*272,415*	*294,594*	*318,896*	*345,084*	*372,800*	*402,077*
E. *Africa*	272,924	306,563	347,791	397,830	458,251	531,213	619,748	728,013	860,462
12. Western Africa	85,973	98,535	114,007	132,973	156,165	184,631	219,799	263,572	317,915
13. Eastern Africa	75,032	82,120	90,910	101,579	114,355	129,384	146,976	167,803	192,725
14. Middle Africa	28,345	30,559	33,303	36,578	40,444	45,001	50,389	56,832	64,427
15. Northern Africa	65,955	75,351	86,712	100,408	116,884	136,843	161,215	191,104	227,748
16. Southern Africa	17,619	19,998	22,859	26,292	30,403	35,354	41,369	48,702	57,647
F. 17. *Northern America*	198,664	213,840	230,409	249,840	272,238	297,348	324,955	354,914	388,264
G. *Latin America*	212,431	245,080	283,899	330,488	386,856	455,131	537,450	636,447	755,579
18. Tropical South America	112,479	131,334	153,838	180,933	213,792	253,728	302,118	360,626	431,302
19. Middle America (mainland)	46,811	54,926	64,775	76,878	91,921	110,535	133,312	161,037	194,816
20. Temperate South America	32,796	35,896	39,287	43,018	47,123	51,647	56,587	61,966	67,786
21. Caribbean	20,345	22,924	25,999	29,659	34,020	39,221	45,433	52,818	61,675
H. *Oceania*	15,713	16,974	18,418	20,159	21,997	24,233	26,655	29,493	32,508
22. Australia and New Zealand	12,687	13,635	14,669	15,859	17,202	18,689	20,298	22,043	23,977
23. Melanesia	2,166	2,339	2,549	2,800	3,095	3,444	3,857	4,350	4,931
24. Polynesia and Micronesia	860	1,000	1,200	1,500	1,700	2,100	2,500	3,100	3,600

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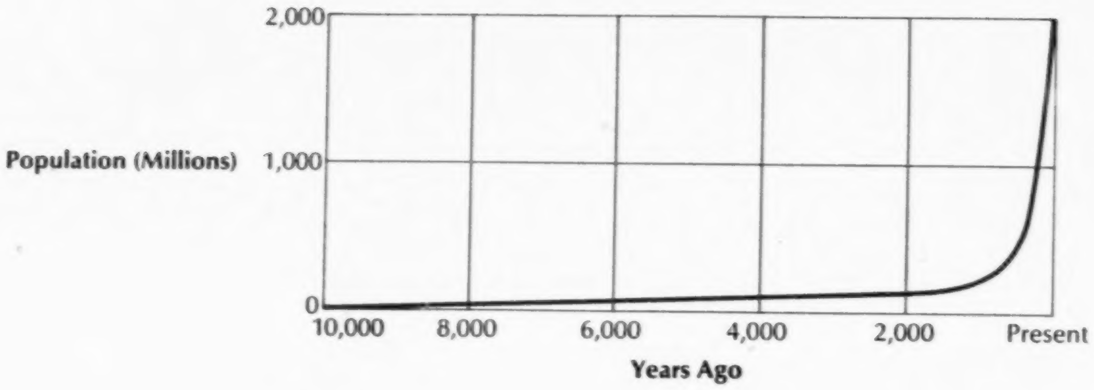
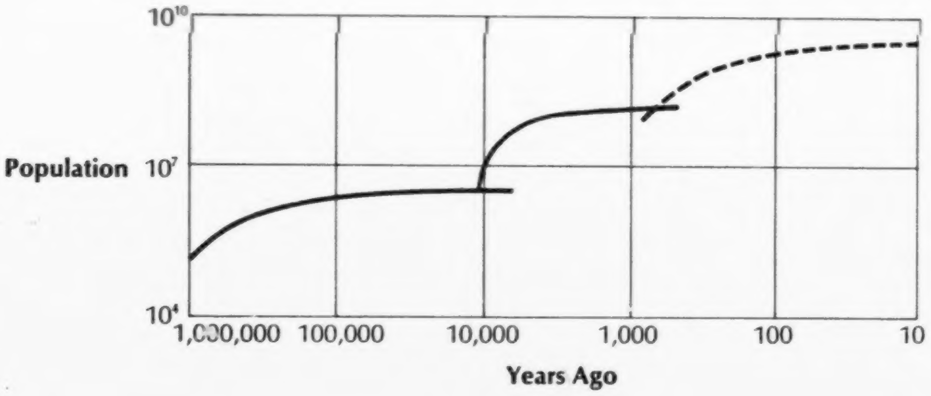
[a] Including Europe, the USSR, Northern America, Japan, Temperate South America, Australia and New Zealand.

[b] Including East Asia less Japan, South Asia, Africa, Latin America less Temperate South America and Oceania less Australia and New Zealand.

Population Growth



Arithmetic population curve plots the growth of human population from 10,000 years ago to the present. Such a curve suggests that the population figure remained close to the base line for an indefinite period from the remote past to about 500 years ago, and that it has surged abruptly during the last 500 years as a result of the scientific-industrial revolution.



Logarithmic population curve makes it possible to plot, in a small space, the growth of population over a longer period of time and over a wider range. Curve, based on assumptions concerning relationship of technology and population as shown in chart, reveals three population surges reflecting toolmaking or cultural revolution, agricultural revolution, and scientific-industrial revolution.

The above graphs from Scientific American, September 1960. "The Human Population," by E. S. Deevey, Jr. Used by permission.

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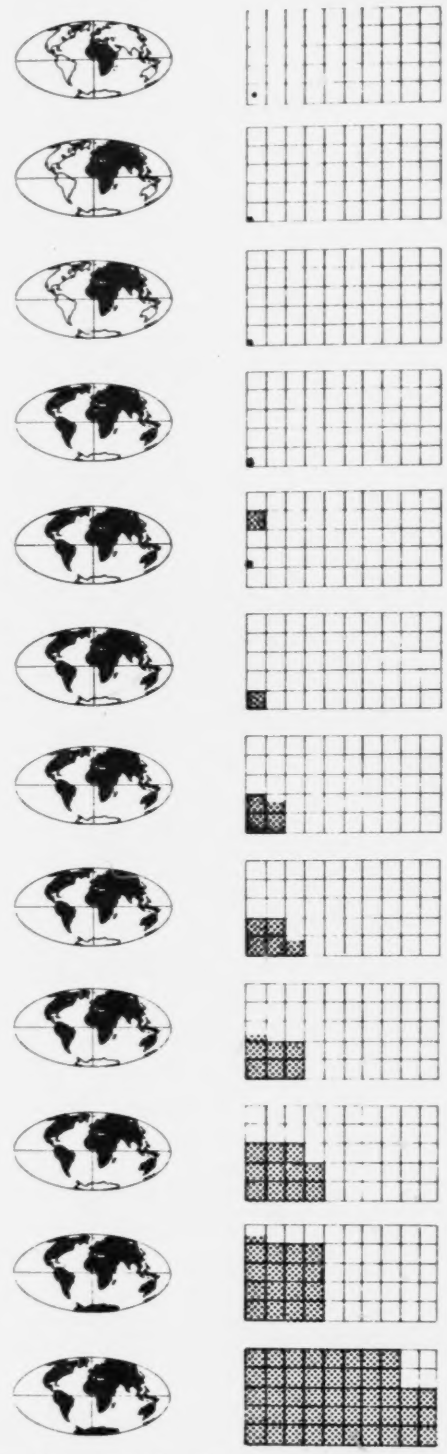
Population Growth



Years Ago	Cultural Stage	Area Populated	Assumed Density per Square Kilometer	Total Population (Millions)
1,000,000	Lower Paleolithic		.00425	.125
300,000	Middle Paleolithic		.012	1
25,000	Upper Paleolithic		.04	3.34
10,000	Mesolithic		.04	5.32
6,000	Village Farming and Early Urban		1.0 .04	86.5
2,000	Village Farming and Urban		1.0	133
310	Farming and Industrial		3.7	545
210	Farming and Industrial		4.9	728
160	Farming and Industrial		6.2	906
60	Farming and Industrial		11.0	1,610
10	Farming and Industrial		16.4	2,400
A.D. 2000	Farming and Industrial		46.0	6,270

Population growth, from inception of the hominid line one million years ago through the different stages of cultural evolution to A.D. 2000 is shown in the chart above. In lower Paleolithic stage, population was restricted to Africa, with a density of only .00425 person per square kilometer and a total population of only 125,000. By the Mesolithic stage, 10,000 years ago, hunting and food gathering techniques had spread the population over most of the earth and brought the total to 5,320,000. In the village farming and early urban stage, population increased to a total of 86,500,000 and a density of one person per square kilometer in the Old World and .04 per square kilometer in the New World. Today the population density exceeds 16 persons per square kilometer, and pioneering of the antarctic continent has begun.

From Scientific American, September 1960. "The Human Population," by
E. S. Deevey, Jr. Used by permission.

Day 12: Urban Environmental Problems--Noise Pollution--Effects of Crowding (Discussion of Reading)

Knowledge Objectives:

To know that intense noise can cause both permanent and temporary loss of hearing

To know that intense noise can impair both your physical and mental health

To know that high concentrations of people crowded in small areas cause severe social problems

Skill Objectives:

To experience the effects of severe crowding

The students should be able to identify four effects that noise has upon man--hearing loss, speech disruption, loss in performance capacity, and annoyance

Materials: Tape on noise; reading

Equipment: Tape recorder

Method:

When the students enter the classroom, have them either stand or sit (on floor or at desks) very close together. Then start by playing the tape. Have the students classify the tape by that which is noise and that which is sound. (The tape begins with a quiet interlude, with increasing amounts of noise being added until it reaches a high intensity of noise. To personalize the activity, create your own tape of loud student activities in your classroom and school and play today.)

When it finishes, the teacher should remain silent until the students voluntarily react to the tape or until a couple of minutes pass. Ask the students what the message of the tape is. Which portions were sound or noise? To dramatize this, a teacher would have a student stand in front of the class and try to summarize the students' reactions, while at the same time playing the loud part of the tape. Analyze the problem immediately created by noise pollution. In what ways does excessive noise affect the health or performance of man? Why are some noises tolerated and others not? List those items that create noise pollution: motorcycles, jackhammers, etc. Discuss the types of noise pollution which exist in your community. Examine what is being done to eliminate these problems. List the major contributors to noise pollution in your community. Assign students to watch for examples of noise pollution to report to the class tomorrow. Discuss the reading, paying particular attention to the health effects of excessive noise. Discuss the concept and range of "decibels."

When discussion on the effects of noise is over, begin to analyze the class's particular conduct today which the crowded situation created. Examine any conflicts created by this crowding and relate them to similar situations of life (for example, ball games, buses or subways, airplanes, reception rooms, bathrooms, gymnasiums, etc.). Examine the effect severe crowding has on mental concentration, physical health, and human spirit and the concepts of freedom (to move, to speak, etc.). List on the blackboard any and all disturbing situations relating to crowding and waiting, particularly any conflicts which develop due to them. Relate to the need in urban centers for parks, bicycle and pedestrian paths, open space, etc. Discuss examples in your community of both poor and good planning relative to crowding.

TEACHER'S MANUAL

Day 13: Man--An Endangered Species? (Discussion of Reading)

Knowledge Objectives:

To know that municipal, state, and federal governments are considering and passing legislation to protect our environment

To know that overpopulation and unbridled technology are two of the general reasons for the destruction of the environment

To know that overpopulation and unbridled technology not only destroy the environment but threaten the continued existence of man

Skill Objectives:

To summarize the problems studied that relate to the environment

To reach a generalization about the causes of the environmental crisis

Materials: Reading

Method:

Begin by summarizing all the problems of the environment studied thus far in the unit. Examine in detail the problem areas and the problem causes. Look for general causes underlying all the problems summarized on the blackboard. Include such things as overpopulation, technology abuses, lack of economic incentives or penalities, man's view of nature, social and cultural change, man's desire for material wealth, and man's wasteful attitude (frontier psychology). Discuss the article. How does overpopulation threaten mankind? How does unbridled technology threaten mankind? Summarize the seriousness of all these problems. Examine the level of awareness of most people. Determine if man is an endangered species. Have the students support their answers. Determine how man can solve these problems.

Have the class write a paragraph explaining what each thinks are the main causes of the present environmental crisis. Have the class use data from the materials studied in this unit to support their answers. (If time permits, divide the class into groups and have them write a series of questions for a questionnaire they would administer to see how aware parents, friends, and other students are of the problems of the environment.)

TEACHER'S MANUAL

Day 14: What Is Being Done (Slide-Tape Show)

Knowledge Objectives:

To know ways that individuals have helped conserve their local environment
To know seven major problem areas of the environmental crisis
To know that there are solutions to the pollution problems, some simple, others complex and expensive

Skill Objectives:

To establish goals for conserving the environment
To identify at least ten solutions to the pollution problems

Materials: Reading; slide-tape show, "Solutions to Environmental Problems"

Equipment: Slide projector, tape recorder

Method:

In Day 13 the class determined some causes of the environmental problems. Today the class will look at some solutions. Inquire as to how an individual can help solve the problems of the environment. Review the students' suggestions developed on previous days. (A dittoed handout summarizing the students' suggestions could be given to the students for review purposes and to see if they are still following their own recommendations.) Determine what groups of citizens can do to help protect the environment. A discussion of the reading will help answer the question. Show the slide-tape show. Have the students identify the seven problem areas described in the filmstrip and list at least ten solutions (the filmstrip gives many more) to the problems of the environment. At the conclusion of the filmstrip, discuss the solutions listed by the students. Near the end of the period, hand out the combined U.S. Department of Interior-General Services Administration "Environmental Action Guide" and discuss it with the students. Compare it with the students' ideas.

Try to stimulate interest in having the students implement their ideas and the ideas from the reading and the "Environmental Action Guide." Start committees, centers, and groups whose aim it is to work for environmental improvement.

If the filmstrip is not purchased by your school or district, hand out the Action Guide at the start of the class and begin your discussions with it. Spend more time organizing action groups for both school and community.

ENVIRONMENTAL ACTION GUIDE

Goals:

(1) Good, balanced, community-wide planning
(2) Good zoning ordinances, strongly enforced
(3) Effective conservation agencies
(4) Effective pollution control measures for air and water
(5) Modern methods of solid waste disposal; end to open burning
(6) Effective sign and billboard control
(7) Junkyard screening and control
(8) Adequate open space
(9) Playgrounds, parks, and other recreation areas
(10) Attractive, convenient, downtown malls
(11) Protection of watercourses, natural areas, especially in or near cities
(12) Protection of wildlife
(13) Trail systems for walking, bicycling, and jogging
(14) Conservation education in schools
(15) Underground utility lines
(16) Proper maintenance for public places: parks, city streets, etc.
(17) Personal code of conservation ethics for everyone

Steps to avoid waste:

(1) Use disposable paper and plastic goods only as necessary.
(2) Buy products in returnable bottles.
(3) Wash and reuse plastic bags and glass and plastic containers rather than throw them away.
(4) Try to buy items that are not excessively packaged.
(5) Buying one large-size product rather than several smaller sizes or individual servings is less expensive and less wasteful.
(6) When you shop, take a reusable mesh shopping tote with you as the Europeans do, instead of using paper bags from the store.
(7) Pack children's lunches in lunch boxes.
(8) Try to buy good-quality, long-lasting toys. Broken toys add to the disposal problem.
(9) At the gas station, do not let the attendant "top off" your gas tank; this means waste and polluting spillage.

Alleviate disposal problems:

(1) Do not litter. This is the easiest pollution to stop.
(2) Make garbage compact. Flatten cans, boxes, and cartons or stack them inside one another to conserve space.
(3) Do not use colored tissues, paper towels, or toilet paper. The paper dissolves properly in water, but the dye lingers on.

(4) Use decomposable (biodegradable) containers--pasteboard, cardboard, or paper. Soft plastic bottles made of polyvinyl (PVC) give off lethal hydrocloric acid when incinerated.

(5) Never flush away what you can put in the garbage. Especially unsuspected organic cloggers like cooking fat (give it to the birds) or coffee grounds and tea leaves (great for gardens).

(6) Filter tips on cigarettes are practically indestructible. Do not flush them down the toilet because they will ruin your plumbing and clog up pumps at the sewage treatment plant.

(7) Disposable diapers could clog up plumbing and septic tanks.

(8) Drain oil from power lawn mowers or snowplows into a container and dispose of it; do not hose it into the sewer system.

(9) Observe parking regulations so that sanitation men can clean the streets.

Recycle:

(1) Save newspapers, magazines, cans and glass containers and take them to the nearest recycling location. Contact a local environmental group for specific information.

(2) Encourage manufacturers to establish recycling centers.

(3) Encourage money-raising programs for young persons or organizations through collecting papers, cans, and glass for recycling.

(4) Reuse your scrap paper.

(5) Return wire hangers to the cleaners.

(6) Use live Christmas trees and replant them.

(7) Donate magazines and paperbacks to hospitals or similar organizations.

(8) Bring old usable clothing to thrift shops for resale, or donate it to charitable organizations.

(9) Be willing to purchase and reuse recycled products.

Use household products carefully:

(1) Use detergents with care. Phosphate detergents can upset the ecological balance of aquatic life. Substitutes are being developed, but have not yet been perfected.

(2) Use soap for washing all but heavily soiled items if you live in a soft-water area.

(3) Measure detergents carefully. If you follow manufacturers' instructions, you will help cut a third of all water pollution.

(4) Do not use products that contain solvents (petroleum distillates) if alternates are available, such as water-based paint.

Garden "naturally":

(1) Use organic fertilizers.

(2) Build a compost heap. Include vegetation such as hedge and lawn clippings and leaves. Eventually you can spread it as fertilizer--nature's way of recycling garbage.

(3) Make certain fertilizer is worked deep into the soil, do not hose it off into the water system.
(4) Avoid the use of persistent pesticides. These include the chlorinated hydrocarbons (aldrin, dieldrin, endrin, heptachlor, chlordane, and lindane) plus compounds containing arsenic, lead, or mercury.
(5) Buy helpful insects (ladybugs, praying mantises, aphis lions, and parasitic wasps) to control destructive garden pests.
(6) Strong-smelling herbs, such as mint, sage, and basil, repel insects and help keep down your use of pesticides.
(7) If you must spray, use the right insecticide. If at all possible, use botanicals (natural poisons extracted from plants) like nicotine sulfate, rotenone, and pyrethrum.

Reduce air pollution:

(1) Motor vehicles contribute a good half of this country's air pollution. When possible, walk, ride a bicycle, use mass transit systems, or form car pools to help reduce the number of cars on the road.
(2) Keep your car in good operating condition.
(3) Do not idle the car unnecessarily.
(4) Check that the car is equipped with one or more emission-control units and that they operate properly.
(5) Consider buying a low-horsepower car.
(6) Buy lead-free gasoline and encourage all gasoline manufacturers to "get the lead out." (Lead, by the way, chews up metal--including antipollution catalytic mufflers.)
(7) Do not burn leaves or garbage.
(8) If you must use your fireplace, burn wood not murky cannel coal, leaves, or garbage. Charcoal should never be used indoors because it releases poisonous gases.
(9) Kick the cigarette habit and we'll all breathe a lot easier.

Conserve water:

(1) Do not leave water running. If it has to recycle too fast, treatment plants cannot purify it properly.
(2) Keep a jar of water in the refrigerator to avoid the need of running water from the tap to cool it.
(3) Repair leaking faucets immediately.
(4) Take reasonably short showers instead of baths. The average bath uses more water than a seven-minute shower.
(5) Run the dishwasher and washing machine with one full load rather than several small ones.
(6) One flush of your toilet unnecessarily uses seven gallons of water. If they fit, put a brick or two in your toilet tank or ask your plumber to set the toilet for the minimum amount of water.
(7) Do not overwater lawns and gardens.

Conserve electricity:

(1) Production of power pollutes, either by creating smog or by dirtying the rivers, so use less power.
(2) Turn off lights in rooms not in use; turn off appliances when not in use
(3) Turn off air conditioners if no one will be at home. Adjust blinds and shades to keep out the sun. Air conditioners will then have less work.
(4) In winter, turn house heat down at night.
(5) Try to avoid using major appliances during periods of peak power demands. Save vacuum-cleaning, working with power tools, and similar chores for the weekend when power demands are generally low.

Avoid excess noise:

(1) Keep radio, TV, or phonograph tuned to a reasonable level.
(2) Do not buy excessively noisy toys for children.
(3) Keep household appliances in good condition.
(4) Do not use your car horn unless necessary.

Get involved:

(1) Know your community's laws concerning pollution control, zoning, building regulation, and beautification standards.
(2) Support improved municipal sewage treatment and solid waste disposal facilities.
(3) Write to pertinent officials about your concern and ask them what they are doing about environmental problems that interest you.
(4) Work with existing groups for pollution control. Help organize groups to fight problems in your neighborhood.
(5) Encourage neighborhood clean-up campaigns.
(6) If you work with children, alert them to the dangers of polluting.
(7) Try to get an environmental shelf established in local and school libraries.
(8) Patronize stores that specialize in unpesticided, organically grown food in biodegradable containers.
(9) Complain about unsightly billboards and signs to advertisers and local officials.
(10) Report instances of abandoned cars or offensive industrial waste to local officials, and note the time, location, and nature of the offense.
(11) If you see something wrong and do not know whom to contact, bombard newspapers, TV, and radio stations with letters. Publicity hurts polluters.

TEACHER'S MANUAL

Day 15: Manpower Solutions to Environmental Problems

Knowledge Objectives:

To know that, if properly used and controlled, technology is one of the ways to solve the pollution problems

To know that manpower needs to solve the problems of the environment

Skill Objectives:

To identify five different occupations that deal with environmental control

To ask questions about the manpower needs and opportunities in environmental control

Materials: Reading, slide-tape show, "Environmental Occupations"

Equipment: Slide projector; tape recorder

Speaker: School vocational counselor (he must be thoroughly briefed beforehand and have in his possession Chapter 2 of this handbook)

Method:

Discuss again the creation and operation of the aforementioned action groups (if not completed in the previous session).

Inquire as to what the manpower needs are and what the job opportunities are to solve the problems of the environment. Explain to the students that the slide show answers this. Have the students identify and list at least five different occupations involved in overcoming the problems of the environment from the slide-tape show. Relate the reading on engineering to the general subject of environmental careers. When the slide show is completed, introduce the counselor and explain that he is in class to answer the students' questions generated by the filmstrip and the previous days' lessons. Then let the counselor use the remainder of the class time. If the filmstrip is not purchased by your school or district, use Chapter 2 of this handbook in class with the counselor. Make sure the counselor understands he is there to promote career education, particularly environmental vocations.

The counselor should be aware that a mere recitation of specific environmentally related careers and occupations is not sufficient. The discussion should center around career selection in general (particularly for seniors), then move on to a discussion of the realities of the occupational marketplace, the need for various types of training, the methods of obtaining that training, and then finally to particular environmental occupations, their benefits to society and to the individual, their forecasted growth (based upon various factors stated in Chapter 2), and other pertinent information.

In lieu of today's activity, if difficulties with the filmstrip or counselor prevent this discussion, a teacher could allow for review of material and concepts covered to date or administer a unit examination.

Day 2: Reading--Man and the Environment

Adapted from U.S. Department of the Interior Environmental Yearbook, Our Living Land (Washington, D.C.: U.S. Government Printing Office, 1971), pp. 8-13.

> "Man has built his civilizations on a crust of land thinner than the skin of an apple compared to the whole fruit."

Our planet came into existence some 4-1/2 billion years ago and through this long span of time, there gradually was formed a thin outer crust that we call "the land." As geologic time is counted, man made his appearance only a moment ago.

Visible to man as continents and islands, the crust covers the earth. However, most of it (nearly three-quarters) is screened by water, chiefly oceans and glaciers. The Earth's crustal surface--man's domain and vulnerable to a variety of natural and man-made occurrences--is tremendously versatile. It produces our food, provides our basic fuels and metals, and supports our steel and concrete structures and our vehicles.

The thinnest part of this crust, the soil, is a fairly recent addition. The most productive, it is also the most fragile. It must sustain life, but modern man reduces its vitality and hastens erosive processes. Each day, rain and running water sweep eight million tons of the land's substance into the sea. The material carried seaward contains natural nutrients. In addition, it contains natural and man-made contaminants, many of which kill valuable ocean life.

In a sense, our land must be considered a nonrenewable resource because some areas are being depleted far faster than nature is creating new fertile areas of productivity. The natural riches stored in the Earth's crust are finite, yet they are being depleted at ever increasing rates. Some experts say that the world is overpopulated; others contend that it easily can support more life. Both agree, however, that better conservation practices are absolutely necessary on a sustained global basis if environmental and resource crises are to be avoided. Man has altered numerous features of the Earth's surface for his own purposes. But these changes have not always been to his advantage.

Despite man's efforts to modify some of the Earth's features, ours remains a dynamic planet. It operates within implacable frameworks of natural law and forces, and thus is hostile to many of man's endeavors.

Some of the continuing reminders that man is a tenant and not the "landlord" of the earth are volcanic eruptions. Such eruptions--part of the natural scheme of things since Earth first shuddered through creation--have time and again killed people and destroyed property. Still, man continues to populate volcano-prone areas in many parts of the world. In 1919, a mud-flow eruption from Kelud Volcano in Java destroyed scores of villages and snuffed out more than 5,000 lives.

Mt. Vesuvius, in 79 A.D., buried Pompeii and all its thousands of inhabitants. An explosive eruption of Java's Krakätoa in 1883 triggered a tidal wave that killed

35,000 persons. Mt. Pelee's warning went unheeded by 30,000 people in St. Pierre, Martinique, and they died, mostly by asphyxiation from poisonous fumes of the 1902 eruption. Recent volcanic eruptions in Central America are reminders that hundreds of volcanoes are merely dormant--not extinct--and, like delayed time bombs, can threaten man and his works.

Earthquakes, also natural phenomena, occur with disturbing frequency and with catastrophic results in the many parts of the world that, because of their geologic makeup, are prone to these releases of energy. The Peruvian earthquake in the summer of 1970 resulted in the deaths of more than 50,000 people and untold numbers of livestock and wildlife. Nearly half the deaths were caused by the collapse of unstable dwellings that could not withstand the shaking earth. Other victims were smothered under vast slides of ice, rock, and mud triggered by the shock that moved at fantastic speeds down mountainsides in populated valley towns.

Moving glaciers are also constant reminders of natural forces that are not subject to man's control. Their advances and retreats often reshape regional terrains. Although they store about three-fourths of all the fresh water in the world, man has not yet managed to utilize their full potential.

Such events as volcanoes, earthquakes, landslides and floods continue to have far-reaching impact on the Earth's surface, as they have during the more than four billion years of the planet's existence. In themselves they are neither angry nor benign. They are merely relentless forces, constantly part of a grand system by which nature seeks equilibrium. Man must reckon with these forces when he and his works move into diaster prone areas.

Man's sources of energy--oil, natural gas, coal, tar sands, oil shale, and nuclear materials--were forged in the Earth's crust by many and varied geological processes over long periods of time. Unfortunately, these resources have not always been developed with a concern for their eventual exhaustion.

The mining of coal is a good example. Man has been mining this fuel for about 800 years. But one-half of all the coal ever taken from the ground has been mined and burned in the past three decades. Underground mining in the United States still leaves about half the coal in place. This is because it is cheaper, in the short run, to abandon it and seek new beds to develop. Man must remember that many other passengers of the spaceship Earth are yet to be born, and must temper his destructive short-term practices for saner long-term ones.

The petroleum industry is much younger than the coal-mining industry, but now meets a larger percentage of our energy needs. The first commercial well in the United States at Titusville, Pa., was drilled in 1859 and struck oil at 69 1/2 feet. It produced only nine gallons of oil per day. Today the United States has more than 500,000 wells, and the deepest producer has been driven to 22,790 feet. The daily output is about 40 million times that of the first well at Titusville.

Consumption of most of our other nonrenewable resources continues at exceptionally high rates. The value of domestic minerals produced in a recent year was approximately $27 billion, an 8 percent gain in value over the previous year.

Demographers who count the pulse of populations estimate that the world has been the home of nearly 80 billion people. Today's population of more than 3.5 billion is the greatest to occupy this planet at any one time. If the growth pattern follows forecasts, the world's population will double shortly after the year 2000. In this context, the supply and demand pattern affecting our natural resources becomes a matter of vital concern.

Take forests as an example. Canada estimates that if all its 600 million acres of forest land were producing young trees, they would generate enough oxygen to meet the requirements of 12 billion people. And in arguing for sound forestry methods, Canadians also point out that if trees are permitted to rot and die, they would extract as much oxygen from the air as young trees produce. The moral: Keep the young forests growing while we make use of the mature timber stands for our needs--and, in so doing, preserve and even enhance for man the life-sustaining features of the environment.

Perhaps this interrelationship of all living things is what John Donne sensed as he wrote that "no man is an island entire of itself, every man is a piece of the continent, a part of the main."

This is the beginning of understanding the modern science of ecology. It represents that in the past only a few fleeting seconds as man's tenure on Earth is counted against a multibillion-year history, but we have entered the "Age of Ecology."

This plant, on its whirlwind travels, has journeyed a trillion miles through space since the days nearly five centuries ago that colonizers from Europe gained a first precarious foothold in North America. They came to that "good piece of geography" which Robert Frost said every nation must have. Once forests marched down to the water's edge and extended inland farther than any man could see, and there seemed no limit to the woodlands, the rich plains, the sparkling waters, the wildlife, or the land itself. But the eons of painstaking craftsmanship by nature were not figured into the value put on the resources. Around 1700 prime land in Pennsylvania was selling at $2.00 an acre. "Ordinary" land brought 50 cents. In Virginia, at about the same time, ten of thousands of acres were given away to promote settlement. Cutting and clearing with little thought of erosion hazards were routine operations in subjugating the land.

Even as the land and the resources later came to be recognized as limited and often nonrenewable, the old attitudes on use still prevailed and have not yet been surmounted. Poor construction practices, random cutting of forests, indiscriminate mining methods, contamination by sewage and chemicals, and haphazard community planning all contribute to exhaustion of this land. In pleading for wise use without abuse of resources, many authorities emphasize that we must harvest our natural bounties judiciously because the resource storehouse is not automatically being replenished.

Although some of the worst examples of soil erosion and pollution in many forms are to be found in the vicinity of the nation's capital, there are nevertheless many indications that America is reversing the trend of land and water abuse. Development is being tempered with decisions hard fought decision, some reached in the courts of law, that environmental degradation begins on the land and that here it must and will be halted.

At long last people are beginning to heed the words written 108 years ago by the great American, George Perkins Marsh, who said:

> Nature has provided against the absolute destruction of any of her elementary matter the raw material of her works, the thunderbolt and the tornado, the most convulsive throws of even the volcano and the earthquakes being only phenomena of decomposition and recomposition. But she has left it within the power of man to derange the combinations of inorganic matter and of organic life which through the night of aeons she had been proportioning and balancing to prepare the earth for his habitation when in the fullness of time his Creator should call him forth to enter into its possession.

Day 3: Reading, "Water: The Environmental Challenge"

Adapted from "The Story of Water," *River of Life--Water: The Environmental Challenge,* U.S. Department of the Interior, Environmental Report (U.S. Government Printing Office, 1970), pp. 6-11; *idem.*, "Water: The Environmental Challenge," pp. 22-29

Water has three natural forms: liquid, solid, and vapor. With changes in form, it has recycled itself constantly for millions of years. From the time, hundreds of millions of years ago, when water vapor formed Earth's first clouds and the first rain fell, this process of recycling has continued with little change in the quantity of Earth's water. In whatever form it takes, water is simply the chemical combination of atoms--two hydrogen atoms and one oxygen. Every drop of Earth's original water supply is still in use ... in the atmosphere, and on the surface or beneath it.

Earth's total water supply is 326 million cubic miles. A small percentage of the total supply is always in motion in the hydrologic cycle in a liquid or vapor state. Less than 0.05 percent of Earth's water supply is moving through the cycle at any given moment. The remainder of the supply is distributed in varying amounts to every part of Earth. Over 97 percent is held in the oceans, 2.15 percent is frozen in glaciers and polar caps. The remainder, less than 1 percent, is in the Earth's lakes, rivers, streams, and underground reservoirs.

Only about 0.06 percent of Earth's water is available for use by man and nature as surface and ground water. Ground water is merely water which has filtered through the surface crust of Earth and remains temporarily trapped in the subsurface rock. As the quantity of ground water builds up, the water table, or highest level of subsurface water, is raised. This supply of usable water, though small in relation to Earth's total supply, is now generally sufficient for the needs of man and nature. As world population and industrial development grow, however, existing supplies may no longer meet the demands. Serious shortages in distribution occur today in more populated areas. Water tables are lowered when the population density and development of an area consumes more water than is replenished in the watershed. Reservoirs are built, deeper and deeper wells are drilled; however, these measures often affect the water table in the entire watershed. The quantity of available water is further limited by pollution of our water supplies.

Over the years, in his persistent fight to master the world, man has been irresponsible in the treatment of the vital surroundings that mean survival--choosing, using, discarding recklessly, and leaving in his wake a mounting mass of solid debris and a growing volume of contaminated liquids to be inherited innocently by following generations. In this closing third of the 20th century man is playing a new game of Russian roulette: All the chambers are loaded, one of the bullets is water pollution, and throughout the world there is a growing awareness that we have been derelict in not pressing the panic button sooner. An instant replay reveals that smog alerts, bans on DDT, overworked sewage-treatment plants, and typhoid inoculations are after-the-fact measures dangling at the end of the corroded chain that carries the final label: "Polluted→do not drink."

Of all our resources, we have mismanaged water the most. Our ability to heap abuse on our surroundings indicates that even though we cannot survive without water, we do not appear to care whether we share the same globe with it. We shave with it, bathe in it, make steel with it, swim in it, drink it, fish from it, load it with chemicals and human and animal wastes, distill it, store it, cool our cars and power plants with it, create attractive fountains from it, build dams and reservoirs to contain it. We change rivers into sewers, lagoons and lakes into cesspools. And we shudder at the tens of billions of dollars that now are necessary to correct our derelictions and restore dignity to our stream life.

New York dumps 24,000 tons of waste every day into nearby swampland which once was home for a wide range of birds and animals. Wildlife, once abundant on and around the Hudson River and Long Island, now is counted only in terms of foraging gulls and rats. The continuous dumping of sewage sludge in New York harbor has killed all marine life in a large area. In a recent four-year period, that metropolitan area expected the ocean to assimilate 10 million tons of waste solids. Overwhelmed by such affluence, part of the sea simply died.

Even the quality of water far below ground--the precious moisture that serves so many agricultural and municipal systems--faces a pollution peril. Untold millions of gallons of poisonous liquid, mostly from industries, are being dumped into the earth each year, hopefully to be assimilated safely. As a consequence of such dereliction in the United States and throughout much of the world, our water resources are in deep trouble. Their deterioration, along with other basics of the environment, has caused Prof. Richard A. Falk of Princeton University to conclude: "At this point, we seem more likely to poison ourselves to death than die of starvation."

The challenge facing this nation and others is awesome. It calls for a worldwide attack on man-created water problems. It suggests that future treatment of this universal resource--all 326 million cubic miles of it--emphasizes pollution curbs while simultaneously taking corrective action to remedy past mistakes. In short, the theme is pollution prevention; the goal is pollution correction.

Since 97 percent of the world's water is in the ocean, the attack on pollution must be macrocosmic, or worldwide. All the nations will be turning increasingly to the sea for food, for minerals, for fossil fuels, and for recreation to maintain a precarious balanced environment on land. Scientist in federal agencies, in colleges and universities, and in foreign countries, agree that when six billion people occupy this planet by the year 2000, the oceans will be called upon to provide a larger percentage of their protein needs. Scientists also agree that valuable minerals and other resources will be extracted increasingly from the seas. At the same time, there is growing concern about the seas' ability to provide for man's need, while man himself seems intent on debasing the quality of these waters though indifference and neglect. There is no national or international policy covering the disposal of wastes in the ocean. Accordingly, it has become a sort of common dumping ground.

In its report, "Marine Resources Development . . . A National Opportunity," the United States Interior Department Comments:

> Our own distressing history in mismanaging our estuaries, bays, and harbors should be warning enough of what could happen when resource development becomes more intense in coastal areas and what could happen eventually even on the high seas. We have become such proficient spoilers that not even the seas are too big for us to ruin . . . .
>
> In planning to dispose of the wastes of civilization in the ocean it must be remembered that the capacity of the natural environment to assimilate wastes is limited. Even the deep ocean has a limited capacity for these purposes.

Increasingly, throughout the world, the battle lines against pollution are being drawn tighter. However, there still are too many gaps in the ranks, particularly in the United States where there has been too little resistance to prevailing and threatened pollution when payrolls are involved. In the United States, there is a growing awareness that there no longer are "little" mistakes. Seemingly small errors and shortcuts increasingly are burgeoning into major tragedies, such as the Santa Barbara oil well blowout in California and the record-breaking spills from offshore wells in the Gulf of Mexico. If the United States is to continue as a world leader, it must set better examples in handling all of its resources. The world can accept honest mistakes, but it rebels at errors based on outright neglect.

Typical of what should not have happened, but did, is the case of Lake Erie. In 1910, speaking at Ashtabula, Ohio, former President Theodore Roosevelt asked for the cooperation of Ohio, Pennsylvania, and New York to help a campaign to get drinking water from Lake Erie. "You can't get water and put your sewage into the lake," said the noted statesman and conservationist. "I say this on behalf of your children."

Roosevelt's plea fell on deaf ears. Those children of 1910 are well past middle age now. They witnessed, in their lifetime, the deterioration of Lake Erie. Because of the oversight of previous generations, children today are denied the joy of swimming in a clean lake.

Meanwhile, many estuaries have become the direct or indirect victims of too much of the discards of nations using their very resources . . . filth poured seaward by contaminated rivers, dumped from barges, or sent surging through pipes. The United States in 1968 dumped 48 million tons of solid wastes into the ocean. In any given year, about half the six trillion gallons of water used by paper mills and allied industries in the United States is returned to our waters--often our estuaries--without removal of their harmful chemicals. The shallow coastal areas, where much of our sea life begins, are being assaulted by things we do not want on land. Dr. Eugene Odum of the University of Georgia asserts that estuaries, if not abused, are 20 times as productive as the open sea and many more times productive than any lush farmland in America.

In his thoughtful book, The Frail Ocean, Wesley Marx adds this sad commentary:

> Like the river nurseries, our estuaries are being mauled piecemeal . . . . The ocean may appear to end at the shore, but its vital processes extend into our bays, up our rivers, and even into our mountain streams, where not only salmon but also sandy beaches are born.

In the United States and the more than 100 other nations with coastlines, the adverse effects of man's actions are most pronounced: massive fish kills from pollution, loss of nesting and resting areas for waterfowl, burial of oyster beds with dredged material, thermal pollution (heating) from chemicals which, while not killing oysters and other shellfish, makes them highly toxic, giving rise to such mysteries as Japan's Minamata Disease, in which 17 people were killed in 1953 from eating mercury-contaminated seafood; and always, the present and increasing frequency of oil spills and seepages.

Take the Cuyahoga River in Ohio, the one that once caught fire as it carried its oily wastes to Lake Erie. It rates fourth among America's most polluted streams, being outranked only by the Ohio River, the Mahoning River, and the Houston Ship Canal. The solution for at least part of the Cuyahoga might be found in the manner Germany treated its highly polluted Emscher River. Instead of trying to restore the Emscher as a river, Germany salvaged it as a drainage stream. Its course was altered, its streambed was raised and lined with concrete, and its banks were attractively landscaped. It now is managed from beginning to end. The entire Emscher receives primary waste treatment before it empties into the Rhine. The Rhine, however, is heavily polluted in other places because it is the victim of many political jurisdictions, none of which fully cooperate to keep the river clean. In converting the Emscher, the Germans saved the nearby Ruhr River. Water is not taken directly from the Ruhr for consumption, although it is quite clean. Instead, as in many places in the United States, water is filtered, pumped underground, and withdrawn as needed. The foresight of Germany in planning the future of the highly industrialized Ruhr Valley, where the population density is 10 times that of the United States, dates back to 1897 with the formation of the tongue-twisting "Ruhrtalsperrenverein, " The RTV or Ruhr Reservoir Association. Today the RTV is alive and well, and the Ruhr Valley flourishes. While paving our polluted streams and rivers is certainly no solution to our water problems, the concept of river management and broad waste water treatment can provide us with attractive water systems acceptable to industrial, recreational, and municipal uses.

In 1964 Germany set another example for the world when it banned the sale of "hard" detergents which cannot be broken down by accepted waste-treatment methods, and therefore considered nonbiodegradable. In 1965 American industry voluntarily followed German's lead by halting production of "hard" detergents. But a new problem then arose in our country--the switch to high phosphate detergents which speed the growth of aquatic vegetation. This causes oxygen deficiency and accelerates the aging process of lakes. Detergent phosphates, fertilizer nitrates, and other pollutants that find their way into Lake Erie have hastened the aging of that body of water--it has aged as much in the past 50 years as a normal lake might age in 15,000 years!

Not all the waste dumped into the ocean, however, is harmful. In fact, at times it is beneficial by encouraging growth of organisms for sustaining fish.

What is not known is how much can be dumped offshore year after year or in what way it should be distributed to avoid major ecological changes. Likewise, the long term ability of the ocean to assimilate the malevolence of radioactive wastes, chemicals, trash and other things man does not want to tolerate on land is not known today. Man must be extremely careful when allowing wastes to be dumped into the ocean to ensure that only beneficial wastes find their way into the seas. There could come a time when great areas of the seas are transformed into deserts . . . devoid of all life . . . "Silent Springs" in the underwater world. To prevent the catastrophe of dead seas, it is imperative that man reexamine his many uses of water and allow in the future only those practices which are not destructive of other life forms.

Day 5: Reading--Air Pollution: The Problem and the Risks

Adapted from The Automobile and Air Pollution, Report of the panel on electrically powered vehicles, U.S. Department of Commerce (Washington, D.C.: U.S. Government Printing Office, 1967), pp. 9-16.

The air surrounding Earth is in bad condition, and unfortunately for all life on our planet, it is getting worse. The atmosphere, like all other related systems on Earth, is a continually changing thing. As a product of the activities of different organisms on the face of the planet, the air we breathe has slowly evolved for millions of years. Originally the atmosphere of a primitive earth contained water vapor, methane, ammonia, and hydrogen. While these elements still remain in part in the atmosphere, various organic cycles have produced an atmosphere which today contains approximately 78 percent nitrogen, 21 percent oxygen, .003 percent carbon dioxide, and the remainder a wide variety of elements. Because mankind and all life forms evolved in the type of atmosphere described above, man would find it difficult, if not impossible, to survive if the atmosphere were radically changed. Unfortunately, he is doing just that by discharging various pollutants into the air.

The atmospheric contamination which accompanies industrial society is a continuing hazard to man and his environment. This pollution shortens life, destroys vegetation, damages property, and threatens to alter basic meteorological processes. The rapid growth in urban areas, combined with ever-expanding per capita needs for technology, energy, and transportation, is increasing the peril and is costing man dearly.

Some effects of air pollution generated by industry, power plants, domestic heating, refuse disposal and transportation, are apparent to all. The damage to buildings and other property and the dirt, odor, smog, and smoke associated with contamination of the atmosphere are obvious. In some cases the damage or discomfort can be traced to a specific pollution and particular source. To date, public action to abate pollution has relied primarily on this course. However, the more serious effects of air pollution may be less apparent. Man cannot observe the gradual and irreversible impairment of his respiratory functions as he does the accumulation of dirt on his shirt collar or the buildup of a cloak of smog over the city on a calm summer day. In addition, the complexities involved in sorting out the ill effects of individual air pollutants have generally made it difficult to attribute specific health impairment to specific pollutants. One fact is clear, however, the evidence identifying serious, and on occasion mortal, effects on man of urban living is overwhelming. Sickness and death rates from chronic respiratory disorders, especially pulmonary emphysema, bronchial asthma, and chronic bronchitis, are higher in urban than in rural environments.

The individual sources of air pollution are as varied as the products of modern technology. Automotive vehicles are the source of most of the carbon monoxide emitted into the atmosphere. In addition, vehicles are largely responsible for emissions of hydrocarbons and oxides of nitrogen, which combine to form photochemical smog, a severe form of air pollution in Los Angeles and in other localities.

Increasing urbanization and rising use of motor vehicles are exposing larger populations to adverse effects from air pollution levels now found only in the traffic-congested central city. The pollutant levels in the central city may also be rising, compounding the seriousness of the problem, but the evidence that significant increases are actually occurring in the core of most American cities is not conclusive at present.

In the past, public action in the prevention of disease has usually awaited the identification of a single causative agent. This pattern of thinking and response is inappropriate to combat the health effects associated with air pollution. The situation was described clearly by the Surgeon General of the Public Health Service in 1962:

> I submit that much of the speculation and controversy about whether or not air pollution causes disease is irrelevant to the significance of air pollution as a public health hazard. . . . Chronic bronchitis, which in Great Britain is established as a specific disease entity, is a good example. It develops over a long period of time and can become crippling through a combination of many factors--air pollution, smoking, repeated and recurring bouts with infectious agents, occupational exposures--all affected, perhaps, by an hereditary predisposition. What then is the cause of chronic bronchitis? The answer is obvious. There is probably no single cause, but there is sufficient evidence that air pollution can and does contribute to its development. This is what really matters, whether we choose to consider it the cause, one of several causes, or simply a contributing factor.[1]

The control of all air pollution sources, including automotive, should be viewed in this context. Automotive emissions in combination with effluents from other sources contribute to an unknown extent to the general problem of air pollution. A delay in action pending availability of conclusive evidence which identifies the precise damage associated with various levels of each pollutant currently contaminating the air is unreasonable. In view of the accumulated evidence on the effects of air pollution in general, all sources must be checked as rapidly as economics and advancing technology will allow.

Epidemiological research, or the study of diseases, on the effects of air pollution on human populations has been under way for the past decade. The emerging conclusions from these studies of the effects of community air pollution on human health were described as:

> The main thrust of the evidence is clear and conclusive--the types and levels of air pollution which are now commonplace in American communities are an important factor in the occurrence and worsening of chronic

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[1] Cited by Secretary of Health, Education and Welfare John W. Gardner in "Air Pollution--1966," Hearings before the Subcommittee on Air and Water Pollution of the Committee on Public Works, U.S. Senate (Washington, D.C.: U.S. Government Printing Office, 1966), p. 23.

> respiratory diseases and may be even a factor in producing heightened human susceptibility to upper respiratory infection, including the common cold.
>
> . . . there still are deficiencies in scientific knowledge of the relationship between air pollution and respiratory disease. A need exists for more quantitative information--for more precise data concerning the pollutants which affect human health and in what amounts and under what conditions they produce their effects. But the qualitative evidence is conclusive. There is no doubt that air pollution is a factor which contributed to illness, disability, and death from chronic respiratory diseases.[2]

Cigarette smokers and those with lung and heart disorders are thought to be in greatest danger from contaminated air.[3]

The killing and disabling potential of the total community air pollution from a variety of sources has been strikingly demonstrated in repeated episodes of acute pollution which have occurred both in this country and abroad. The air pollution catastrophe in London from December 5 through 9, 1952, took an estimated 3,500 to 4,000 lives. The episodes in Donora, Pa., in 1948 Meuse Valley, Belgium, in 1930, and New York City in 1953 and 1966 are other well-known examples of the dangers and discomforts which result from adverse meteorological conditions and high community air pollution levels.

These dramatic occurrences serve as a reminder that clean air is a precious natural resource. While man's daily consumption of food and water totals approximately 7 pounds, he requires about 30 pounds of air each day to survive. The urbanite experiences higher levels of sickness, disability, and death from disorders related to breathing and circulation than does the rural dweller. Direct experimentation to conclusively prove that these effects are a product of air pollution is impracticle, but the accumulating facts associating damage to public health from contaminants of the automobile are growing.

(1) Carbon monoxide. The toxic effects of carbon monoxide on humans have been known and extensively studied for some time. The primary effect is based on its strong affinity for hemoglobin, with which it combines more readily than oxygen, to form carboxyhemoglobin, reducing the capacity of the blood to transport oxygen from the lungs to the tissues of the body. Concentrations of 30 parts per million (ppm) carbon monoxide for more than four hours under controlled conditions will tie up approximately 5 percent of the body's hemoglobin, producing measurable impairment of physiologic functions, such as vision and psychomotor (muscular) performance. Concentrations higher than 30 ppm carbon monoxide are frequently

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[2] Testimony before the Subcommittee on Air and Water Pollution, Committee on Public Works, U.S. Senate, U.S. Department of Health, Education and Welfare.

[3] Gardner, op. cit., pp. 22,23.

observed in urban traffic. These effects would be enhanced by any additional illness or exposure which decreases oxygen uptake in the lungs, or the ability of the blood and circulatory system to carry and distribute oxygen to the living cells of the body. Cigarette smokers, for example, may have carboxyhemoglobin levels as high as 8 percent. An added effect from atmospheric carbon monoxide levels could entail serious health risks.

(2) Hydrocarbons. Presently no direct health hazard is attributable to hydrocarbons in atmospheric concentrations. Certain hydrocarbon derivatives emitted in automobile exhausts may have carcinogenic, or cancer producing, effects on lung tissue, but the evidence is inconclusive. The primary concern with these emissions is their indirect effect through participation in the photochemical reactions which lead to the formation of smog. Plant damage, eye and respiratory tract irritation, and reduced visibility are all associated with the formation and prevalence of photochemical smog.

(3) Nitrogen oxides. Oxides of nitrogen are major participants in photochemical smog reation. The most significant of these pollutants is nitrogen oxide, a yellow-brown gas which significantly reduces atmospheric visibility at low concentrations. It is known to be toxic to man, and deaths and chronic respiratory disease have resulted from exposure to this gas in mines and in farm silos where it is formed in the decomposition of silage. The low concentrations which occur in the community atmosphere have not been identified as damaging to health, but investigations have not been adequate to determine the significance of this pollutant as a public health problem.

(4) Oxidants. Ozone and the peroxyacyl nitrates (PAN), in addition to nitrogen dioxide, are oxidizing agents resulting from automotive exhausts which are found in the atmosphere. These substances are associated with the eye irritation, odor, and respiratory effects of photochemical smog.

(5) Lead compounds. Lead is known to be toxic to humans, but the concentrations required for this effect, either in the body or in the environment, have occurred only in isolated cases, usually as a result of occupational hazards. Lead also has some effects which produce no overt symptoms. It interferes with the maturation and development of red blood cells, allegedly affects liver and kidney functions, and disturbs enzyme activity, but neither these nor other bodily disturbances caused by lead have been detected in the general population to date. Epidemiological studies adequate to detect these effects, should they exist, have not been carried out. In addition to the effect air pollution has on man, it also affects vegetation. Ozone, the peroxyacyl nitrates, and a number of organic oxidants associated with automotive emissions have been identified as the responsible agents for damage to food, forage, and ornamental crops in most of the major metropolitan areas of the United States. Cash crop losses related to air pollution are estimated to be between $6 million to $10 million annually in California alone. Most of the forests around the Los Angeles Basin

have been destroyed by the smog produced in the area. The Oquirrh Mountains of western Utah are nearly defoliated by noxious fumes emitted by various industrial pollutors.

A number of specifically damaging effects on man-made materials have been identified from air pollution, particularly automotive emissions. Ozone and other oxidants in photochemical smog attack many materials, including rubber, textiles, and dyes. No firm estimates on the total costs to the nation from this damage are available.

Many experts contend that air pollution is actually causing significant modifications in the world's weather. Attention has been focused for some time on the effects of rising levels of carbon dioxide in the atmosphere due to increasing rates of combustion of fossil fuels. The infrared absorption properties of CO_2 cause outgoing radiant heat from the earth to be captured near the surface, resulting in an increase in the temperature of the atmosphere. This phenomenon is popularly known as the "greenhouse effect." Should carbon dioxide levels be allowed to rise continually at current rates, the resulting temperature rise might have dire meteorological effects, resulting in the melting of polar ice caps and the raising of ocean levels. This theory has been opposed recently by scientists who allege that world temperatures are actually declining as a result of air pollution due to the increase in planetary albedo, or reflection, from the greater atmospheric turbidity. Other studies suggest the selective formation of raindrops and ice crystals which are nucleated presumably by air pollutants at the inversion layer over urban areas.

The entire area of meteorological effects of air pollutants is speculative at present, and only a beginning has been made in the design of meaningful research programs. It should be remembered, however, that air pollutions affect us all, whether urbanites or rural dwellers. The dust, smog, and grime discharged into the air over Los Angeles or St. Louis eventually are carried away to settle to Earth elsewhere. Except during periods of thermal inversions, the atmosphere usually allows individual masses of air to be pushed around the globe approximately once a month by large storm tracts.

While the past decade has seen a sharp rise in the level of support and scope of research on the effect of air pollution on health and welfare, it is clear that far more must be done. Many problems will require long and intensive study before definitive findings can be reached. The pursuit of knowledge in this area should be given the highest possible national priority.

Day 7: Reading--Solid Waste Problems, "Environmental Effects of Solid Wastes:

Adapted from California Solid Waste Management Study (1968) and Plan (1970), U.S. Environmental Protection Agency, (Washington, D.C.: U.S. Government Printing Office, 1971), pp. VII-1, VII-31.

A fundamental reason for concern about solid wastes is the threat that they impose on the health and well-being of the public and the role that they may play in the spread of communicable diseases. The most prominent health factor associated with solid wastes is domestic flies. Flies are carriers of many disease agents. The demonstrated ability of flies to propagate in enormous numbers in organic wastes, to contaminate themselves in fecal material, and ultimately to contaminate man or his environment, clearly incriminates the fly as a health hazard. Thus, the wastes in which flies develop or in which they become contaminated constitute the primary hazard. The fly is an indicator of a breakdown in basic sanitation when present in a community.

Other disease carriers whose populations are enhanced by the presence of solid wastes include rats, cockroaches, and mosquitoes. Their numbers may become excessive and spill over into suburban and urban areas in situations where inadequate solid waste storage and disposal methods are employed. The threat of plague is increased by poor solid waste management.

While control of communicable disease is of paramount importance, it is more meaningful in discussing the problem of solid wastes to take a broad view of the term "public health." No longer can we restrict attention only to the factors involved in the spread of communicable diseases. Of equal importance is the broad and pressing public interest in all factors of environmental health, including the aspects of comfort, enjoyment of life, and the general physical and mental well-being of the public. On the basis of this broader outlook, there are many points of public health concern which relate to the manner by which solid wastes adversely affect our land, air, and water. In addition to the direct effect of solid wastes on the quality of these three elements are the accompanying physiological or psychological effects on man. These may range from immediate danger, such as physical harm, to merely a less pleasant or comfortable environment, such as that which offends the five senses.

It is recognized that there are three forms of wastes: liquid, solid, and gaseous. There are also three possible receptacles for these wastes: the air, the water, and the land. Solid waste is perhaps unique in that it is the one waste which can directly affect all three elements.

Solid waste disposal as now practiced is a significant contributor to air pollution. Although burning of solid wastes is a traditional means of disposing of this material, this process merely transforms the nature of the material from solid to gaseous wastes. Burning is frequently carried out in open dumps, fields, or by other inadequate methods which produce smoke, odors, unsightliness, and contribute to overall air pollution.

Another familiar practice in most states is disposal of solid wastes into the ocean, bays, streams, and ground waters. The leachate, gasses, and floating debris thus produced contribute to the degradation of ground and surface water quality. The grinding and discharge of solid wastes into sewers are adding to an already overburdened liquid waste conveyance and treatment system and to the loading on receiving waters.

The third element of our environment, the land resource, is suffering severely from "land pollution." The prevalence of open dumps, illegal littering, and indiscriminate disposition of solid wastes constitutes aesthetic eyesores while degrading adjacent property values.

When considering the effects of solid wastes on air, water, and land and the relationships to disease transmission, bear in mind that we are dealing with a highly complex ecosystem. The environment must, therefore, be considered as a whole in any meaningful evaluation of our ultimate responsibilities in the management of solid wastes.

A. Effects on Health

1. Flies

As stated earlier, domestic flies are the most prominent factor associated with organic solid wastes Flies pose a multiple threat to a community: (1) they are vectors of disease, (2) they threaten the cleanliness and wholesomeness of processed foods, and (3) they become intensely annoying pests. Any warm, moist, and organic material is a potential source of fly breeding.

The ability of flies to quickly find suitable material on which to deposit their eggs is well known. The "garbage can" and storage area often play an important role in this phase of the fly's activity. The life cycle of these flies is well adapted to the garbage can environment. The adult female enters the can and lays 50 to 200 eggs that hatch in about eight hours. The larvae (maggots) feed in the garbage for about five days, and then they crawl out of the garbage can and pupate in the ground. With once-a-week garbage collection, many larvae crawl out of the can before the garbage is removed.

Even with adequate storage and collection, flies can still be produced if the final disposal of the refuse is not adequate. Most refuse, upon delivery to a disposal site, already contains many fly larvae which are ready to emerge as adult flies. Unless immediate measures are taken to prevent emergence, large numbers of adult flies will result. The only effective preventive measure now in use by communities in California, for example, is the disposal of solid wastes in a sanitary landfill. Emerging adult flies can crawl up through more than five feet of loose soil, but they cannot penetrate through six inches of compacted soil. Unfortunately the refuse from many communities is taken to a dump rather than to a sanitary landfill. Even if the wastes in the dump are burned every day, most of the fly larvae will not be killed because the wet garbage containing the larvae is not burned. The fire burns only the paper and garbage on the surface; therefore, when the ashes are removed from the surface, the larvae are exposed in the garbage.

The presence of large numbers of adult flies at a refuse disposal operation always indicates a sanitary deficiency. This problem becomes serious when the fly population pressure becomes so high that spillover to the surrounding area occurs. When this happens, flies leave their "source point" and go to an "attractant point" such as a residence, restaurant, or business. Flies have been reported to migrate as far as twenty miles from a source of production.

Several other sources of flies often exist in or near communities. Some of these are:

(1) Grass clippings which are placed in piles or containers for several weeks.
(2) Animal manure from stables, poultry ranches, feedlots, and dairies where the manure is not managed properly.
(3) Cull fruits and vegetables which are dumped in piles or improperly fed to livestock.

In order to obtain effective fly control, adequate management of solid wastes at their source is essential to prevent fly breeding. Consequently, fly control requires area-wide solid waste management from the standpoint of geography as well as types of wastes. Waste management systems that do not include all types of wastes that are capable of producing flies are not adequate.

2. Rodents

Solid wastes are one of the primary sources of support of domestic rodents in communities as well as in rural areas. In addition to rats and mice, several other species of small wild mammals are attracted to man's wastes. These include opossums, skunks, ground squirrels, and cats. Rodents have certain basic environmental needs which are not usually as exacting as those of flies. Stated simply, the two requirements are food and shelter. Exposed refuse furnishes both on a lavish scale.

Improperly stored solid wastes provide an ideal food supply for domestic rodents and other small mammals. Improper storage of household garbage goes hand in hand with the presence of Norway rats in densely settled urban neighborhoods. The use of sturdy containers with tightly fitting lids goes far in reducing the availability of garbage to rats and mice.

Open disposal sites (those in which the wastes are not covered daily with compacted soil) can provide food and harborage for large numbers of rats and mice. The population of rats on a disposal site sometimes runs into the thousands. These rodents are difficult to destroy with poison baits because of the abundant and varied food supply. Burning, even daily, does not eliminate animals from a disposal site. Daily covering with compacted soil does. Industrial and agricultural wastes attract and sustain rodent populations, too.

A disposal site may contain enough food and shelter to support a given rat population level. At certain times of the year, however, an excess of young animals is produced, and in order to survive, some animals may move from the disposal site into adjacent areas. An example of this occurrence was found in one northern California city where the city dump was located about one-quarter mile from a nearby residential area. Residents had for several years been periodically bothered by invading rats until the dump was closed and moved. With the site gone, so were the rats. A properly operated sanitary landfill would have prevented this situation.

A factor of major public health concern arises from the fact that a refuse dump affords a meeting place for field and domestic rodents. Field rodents, such as ground squirrels and chipmunks, are the primary reservoirs of bubonic plague infection in refuse dumps. The refuse dump becomes important if it provides a point of transfer of infected fleas from wild to domestic rodents, thereby increasing the potential for human exposure within the urban population.

In addition to the hazard of infectious disease transmission, Norway rats attracted or sustained by solid wastes may attack infants or small children. Rat-bite statistics, gathered from throughout the United States, indicate that as many as 14,000 persons are bitten annually.

Proper storage, collection and disposal of solid wastes can be a significant deterrent to the rodent population. The open, unmanaged dump often supports many rats, whereas the properly managed sanitary landfill will be free from rodents. For that matter, none of the accepted procedures for processing wastes, if properly designed and managed, should support or attract rats.

3. Occupational Health and Safety Hazards

Occupational health and safety hazards of refuse workers and the general public from solid waste management practices are not often thought to be of any serious nature. However, studies have revealed that refuse workers have an extremely high injury rate.[1] These studies show that the refuse collector has an injury rate twice as high as that for firemen and policemen. These occupational hazards include skin diseases, back ailments, hernia, muscle and tendon injuries, and cardiovascular diseases.

Of the many kinds of wastes that are deposited at disposal sites, some, such as insecticides and other poisons, sewage sludges, and hospital wastes, are particularly hazardous. Hazardous pills, insecticide containers, infectious bandages, etc., can be found lying with such exposure that a person unaware of the hazards could easily pick the item up and remove it from the site. For example, there have been reports of children playing with syringes and needles retrieved from disposal sites. Allowing children access to a site at any time is extremely dangerous and should be prohibited. The exposure of refuse collectors to these hazardous wastes is a constant problem. In many cases these wastes are stored inadequately in open containers and in places where dogs, cats, and children could easily come in contact with them.

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[1] D.P.E. Sliepcevich, The Effect of Work Conditions Upon the Health of Uniformed Sanitation Men of New York City, Doctural Dissertation Series, Publication No. 20,008, University of Michigan, (Ann Arbor: University Microfilms, Inc., 1955)

4. Public Nuisances

Collection and disposal of solid wastes present other features which are sometimes objectionable to the general public. Examples of these are early morning noise from collection operations; dust, dirt, and paper blown from the collection vehicle or the disposal site; odors; unsightliness of vehicles or sites; spillage of liquids or solids onto the street; and the convergence of large numbers of heavy vehicles to the disposal facility. All of these are offensive to the public and can be eliminated or minimized through good management practices.

B. Effects on Water

When solid waste residues of any type are ultimately disposed of to the soil, a potential for water quality impairment exists. Even if waste materials are burned, the ash will contain soluble substances which may dissolve in runoff and percolating water and, thereby, affect the quality of the adjacent surface water or underlying water.

Refuse dumped into streams and other surface waters results in conditions of poor aesthetic appearance and creates nuisances. Dumping over riverbanks and on floodplains is also an undesirable procedure since these materials may be washed into the river during periods of high water. In addition to creating unsightly conditions, these materials may litter the streambed and beaches; create hazards to swimmers, boaters and fishermen; and jam wires on water diversions.

Ground water in the immediate vicinity of the disposal site may become grossly polluted and unsuitable for domestic or irrigation use if the solid wastes intercept the zone of saturation (i.e., below the level of the water table) or if the leachate reaches the ground water. Concentration of common mineral constituents such as hardness, chloride, and total dissolved solids can increase many times over those found in unpolluted ground water.

The contact of decomposable solid wastes with surface water may also result in increasing the organic and mineral content of the adjacent surface water. In ponded water, the decomposing organic material will cause the water to become depleted of dissolved oxygen, resulting in production of odors and discoloration of the water.

It appears, however, that the disposal sites may be sources of bacterial organisms affecting the sanitary quality of adjacent surface waters. One serious problem noted at many of the disposal sites was water-caused nuisance conditions, particularly odors and appearance, resulting from improper solid waste disposal.

The disposal of chemical waste sludges also presents potential water pollution hazards.

C. Effects on Air

There are two classifications of air pollution problems related to solid waste disposal. The first type results from the discharge of smoke, particulate matter, dust, and odorous and possible toxic vapors into the atmosphere. These conditions are objectionable in themselves in that they create hazards and annoyance to people and tend to decrease surrounding property values.

A subtle but immensely important part which refuse disposal can play in the field of air pollution involves the occurrence of urban-type smog. Smog in California may best be visualized as the end result of slow combustion in the atmosphere of gaseous hydrocarbon material to end products of aldehydes, organic acids, and other irritants. The resulting aerosols may obstruct visibility, destroy and stunt the growth of sensitive plants, severely irritate the eyes and other mucous membranes of humans, and perhaps increase morbidity and shorten life. Refuse disposal contributes to this situation principally through the inefficient combustion of solid wastes in dumps, backyard burning, and incinerators.

The pall of smoke rising from the open burning of refuse not only has unpleasant odors, but carries particulate matter into the air. Downwind areas are showered with the particulate matter as the gases cool.

Current disposal practices of agricultural solid wastes are also sources of air pollution. Dust and obnoxious odors from accumulations of manure are common in the vicinity of many cattle feedlots and dairies. Smoke from agricultural and lumbering waste-burning operations also adversely affects the air quality of many portions of the state.

D. Effects on Land

Degradation of the value, usefulness, desirability, and beauty of land can result from inadequate, indiscriminate, or improper disposal of solid wastes. Land pollution results in a wide variety of adverse effects, some of which are obvious, others quite subtle.

One of the more insidious forms of land pollution is the destruction of aesthetic values of land areas by unsightly burning dumps, exposed piles of manure, and metal salvage operations. It is difficult to place actual dollar losses on scenic landscapes which have been defaced by improper solid waste disposal. Those attempting to sell land in the vicinity of a burning dump, however, are well aware of the lowered real estate values caused by the dump operation.

Prompt and adequate application of cover material does more to overcome the poor aesthetic conditions at disposal sites than any other single measure. The cover immediately removes the refuse from sight, which is extremely important. Compaction and prompt covering will also aid in reducing the amount of material scattered by the wind. Blowing papers not only create aesthetic problems at the disposal site but also nuisance problems when spread over adjacent property.

Covering will contain most odors or control their release into the atmosphere. This will not only make the site more pleasant to people, but also reduce its attractiveness to insects, rodents, and other animals. In some areas, exposed refuse will attract large numbers of seagulls or ravens feeding on solid wastes.

A second form of land pollution is solid waste disposal which results in undesirable topographic changes. These topographic changes, while sometimes undesirable in themselves at the time, often result in subsequent environmental changes of much greater consequence. For example, the current popular practice of filling San Francisco Bay tidelands and marshlands with solid wastes may be objectionable from an aesthetic and conservation viewpoint. Perhaps more profound, however, are the resultant adverse effects on the ecology of the marine life of the bay, water and tidal currents and flushing action, and even the climate of the area.

Landfill operations that substantially raise the ground level in areas of flat terrain may result in interference with land drainage or may create barriers which obstruct views, both of which constitute a serious detriment to the environment of nearby residents.

Any finished landfill project should blend in with the landscape and be adaptable to an acceptable use. Positive results may be obtained through landfill operations such as the filling of quarries, marshlands, and canyons, creating more usable land area. It is important to remember that the final land does not have to be flat. The planned sculpturing of finished fills for use as golf courses and parks is an example of this. By not filling the disposal site "to the brim," the site may be more compatible with future land use. . . . Some of the positive effects that are being achieved include land improvement for ultimate use, recreational use enhancement, or the elimination of an environmental hazard such as an abandoned quarry.

Day 9: Reading--"Depletion of Natural Resources"

Adapted from Man . . . An Endangered Species? U.S. Department of the Interior Conservation Yearbook no. 4; (Washington, D.C.: U.S. Government Printing Office, 1968), pp. 76-81.

Modern man's use of minerals illustrates both his inventiveness and his lack of foresight. The technology of mining, processing, and using minerals has advanced rapidly, providing energy and materials in such abundance that, for the first time in history, a majority of the population enjoys a measure of affluence.

But while technology was giving, it also was taking away. Methods that gave access to essential minerals and fuels also damaged man's environment. Giant machines that permit economies in surface mining also scar the land and leave sores of eroded soil and polluted streams. Increasingly productive mineral processing plants often yield ugly mountains of refuse as byproducts. Advancing technology has squeezed more and more energy out of coal and oil but too seldom has that technology provided ways to reduce the air pollutants generated in burning these fuels.

If man is now an endangered species, the danger comes mainly from man himself. Pogo, the comic strip possum, summed it up: "We have met the enemy, and they are us." Paradoxically, it is the successes of technology that make its failures apparent; our material abundance has given us the leisure in which to grow dissatisfied.

More than a hundred years ago at Waldon Pond, Henry David Thoreau concluded that the essentials of life could all be included in one: keeping warm. Shelter and fire keep one warm in cold weather. Clothing conserves body heat. Food is mainly fuel to stoke the body's internal furnace. Thoreau lived as independently as possible, in a cabin built of salvaged materials. He grew much of his own food. His mineral needs were the simplest: iron for his axe and other tools, glass for the cabin windows, sulfur matches, and ink made with carbon black.

Few modern men could live as simply even if they wanted to. Nevertheless, Thoreau's analysis holds true even for the man who rides to the office by subway, buys his food in a supermarket, and gets his power, fuel, and shelter from outside sources. Modern man's warmth depends upon mineral resources.

All the mineral resources that ever will exist are here today: in air, water, and the Earth itself. There is no way to add to what has been given. Man cannot create metals; he can only find them where natural processes have concentrated them. Like the metallic ores that were formed by slow geologic forces, the fossil fuels, coal, oil, and gas, represent solar energy stored by plants over eons of time.

Our resources of fuels and minerals are being dissipated much faster than they were built up, and the rate of dissipation is accelerating. In the past 30 years we have used more coal and oil than in all previous history. It will take less than 20 years to do it again.

The natural checks of ecology make most life forms use their resources conservatively. A species will develop a balance with its food supply and maintain the balance indefinitely. The energy to support this ecological status quo comes day-by-day, from the sun. But modern man is an ecological freak; instead of living on the "interest" from his natural bank account, he has found it necessary to spend capital.

Some time in the future, science may devise ways to create new capital stores of energy and materials. But for now we must expend the resources that we have to survive. Spending this capital wisely is conservation.

Today our nation faces a double dilemma. Today, when our requirements for minerals and fuels are higher than ever, we find that the easily obtained rich deposits of these essential materials have been depleted.

We must somehow extend our mineral resource base--the known and usable supplies--by developing new and markedly improved technology. We must find and develop additional sources of minerals that have thus far remained untapped. More efficient mining methods can make low-grade deposits workable. Better processing techniques can make available more of the mineral values inherent in these deposits. Improved utilization can do the same, and also make our resources serve us longer. But--and this is the challenge that must be met if man is to survive and advance--these essential tasks must be accomplished economically within a context that permits no further contamination or degradation of our environment.

There are several practicable ways in which the known and available supply of minerals can be increased. Earth's crust has not been fully explored; hence, new supplies can be discovered. And resources that are marginal can become useful when the right technology is developed.

One of our most urgent needs is for methods and equipment that will enable us to push far deeper into the earth for minerals. This source is yet unevaluated because it is beyond our reach. To probe it, and to work whatever mineral deposits it holds, will require whole new mining system.

A primary need is for a means of rapid excavation . . . tunneling through the earth's varying strata with a safety, speed, and efficiency far beyond anything now known. New techniques for breaking rock, hauling materials, supporting tunnel roofs and walls, and controlling the total underground environment must be woven into flexible and economic excavation systems. Underground mining must, in other words, be converted from a series of separate operations into a single, continuous process. Only in this way can man hope to tap the potential sources of minerals that now elude his grasp.

Perhaps the greatest challenge of all to man's ingenuity, and a large part of the solution to his double dilemma, lies in the recovery of mineral values from waste. In a typical year, for example, the unburned residues from this country's municipal incinerators contain more than six billion pounds of iron and 400 million pounds of aluminum, copper, zinc, and other nonferrous metals. Incinerator residues, often richer than many workable ores, are plowed into the ground at dumps and landfills across the country.

Our past carelessness in disposing of solid waste from mineral operations now haunts us widely and with a vengeance. In many areas man-made mountains of debris encroach on cities and occupy land that could be put to better use for industry, housing, natural forest areas, and recreation.

The anthracite region of Pennsylvania alone contains almost a billion cubic yards of coal mine refuse. Coal in these waste piles and also in abandoned mines can catch fire and burn for years, polluting the air for miles. There and elsewhere, the "overburden" of earth and rock removed to expose mineral deposits from surface mining and the residues from mineral processing have created problems that are literally mountainous. To get at what we need, we move mountains of earth and rock every year: three billion tons in extracting coal and more than that in mining other minerals.

In a wide-ranging study, it was found that every state has been affected by surface mining. More than three million acres, an area as big as Connecticut, have been disturbed and though attempts at reclamation have been made, more than two million acres--equivalent to a state of Delaware--still urgently require restoration work just to preserve water quality in the streams and rivers that drain them. It was learned also that less than one-third of the land that is surface-mined each year is being properly reclaimed. At this rate, the inventory of damaged land will total five million acres, roughly the size of New Jersey, by 1980.

The disposal of mine and mill refuse also is a mountain-size problem. Solid wastes from extractive and processing operations can be noxious as well as ugly. They may be rich in pyrites, as some coal mine wastes are, and form acid waters that pollute streams and rivers. Or they may contribute choking clouds of dust to any wind that blows.

Most coals and other fossil fuels contain sulfur which, when the fuels are burned, forms sulfur dioxide. This colorless pungent gas, corrosive and toxic even in relatively low concentrations, is a major contributor to air pollution.

Also generated by industrial furnaces is "fly-ash," a gray powdery residue of unburned minerals. Most fuel-burning industries long ago installed collectors to remove this troublesome waste from their stack gases. But once it is collected--in volumes totaling some 20 million tons annually--it then must be disposed of. Simply to do this costs industry between 50 cents and $2.00 per ton.

"Keeping warm" is just as essential today as it was in Thoreau's time. We still require minerals and fuels in ever-increasing amounts to fill this basic need. But clean air, pure water, and space in which to live, walk, and occasionally be solitary are just as indispensable to our physical and intellectual growth as they were to his.

It is true, of course, that times and circumstances have changed. Life today is infinitely more complex, and often more confusing, than it was for one man in a cabin by a pond before the turn of the century. But fundamental truths stay with us and our belief in the value and purpose of life persists.

Man may, at this moment in history, be an endangered species, but he remains a highly resourceful one. His faith holds, as Thoreau's so obviously did, in the maxim: "The future is not in Fate's hands, but ours."

Day 10: Reading--"The Problem of Mercury"

Adapted from National Industrial Pollution Control Council, U.S. Department of Commerce, Mercury (Washington, D.C.: U.S. Government Printing Office, 1970), pp. 7-12.

Mercury and mercury compounds are widely used in industry and agriculture because of their unusual properties. Because mercury is toxic to living organisms, it has long been used by the agricultural chemical industry as an effective inhibitor of the growth of fungi on agricultural seeds as well as in some pesticides. For many years mercurial compounds were used in the pulp and paper industry to prevent the growth of slime on wet paper pulp in process or storage. However, as a result of a Food and Drug Administration ban on this use in connection with paper which might come in contact with food, the use of mercury as a slimicide in the United States had virtually ceased before 1970. Mercury is used by the paint and varnish industry to meet marine and other requirements for antifouling paints for ships and for mildew-proofing paints because of its ability to prevent or slow down undesirable growths.

Because mercury is a liquid at normal room temperature and is also an excellent electrical conductor, the electrical industry has used it extensively in household and other long-wearing and virtually silent electrical switches. Mercury has an unusual ability to combine with certain other materials on a highly selective basis. This has led to its use by chemical and metallurgical industries in a number of processes requiring selective separation of materials. Medical and dental laboratories use mercury because of its mechanical, physical, and chemical properties. The instrument industry uses this liquid metal in thermometers and other temperature-recording devices because it remains a liquid over a wide range of temperatures and has a conveniently large coefficient of thermal expansion. The largest single industrial use of mercury in recent years has been in the manufacture of chlorine and caustic soda, both of which are basic materials in many manufacturing processes. The consumption of mercury in each of the past five years has ranged from 69,517 flasks (about 2,650 tons) to 79,104 flasks (about 3,000 tons).

Contamination of the environment by mercury has recently come increasingly to public attention. The Federal Water Quality Administration established that mercury pollution across the nation had become more widespread than previously realized. Abnormal amounts of mercury have been found in some water, fish, and game birds in at least 33 of the 50 states. The toxicity problem posed by mercury waste concentrations is complicated by the fact that it has been established that microorganisms can consume mercury, convert it into methylmercury and bring it into the food chain. (Abnormal amounts are considered to be over 0.5 parts per million (ppm) in food and 0.005 ppm in drinking water.)

Although some mercury will inevitably be present in the environment because it is a natural element, it is nevertheless important for the industrial sector to avoid adding to the natural concentrations. This involves eliminating mercury from industrial waste waters and air discharges whenever it can be detected and controlled.

Mercury has been used by man for much of his existence. Aristotle mentioned the use of mercury, and the Almaden Mine in Ciudad Real Province, Spain, has been producing mercury since 400 B.C. This mine alone has produced over seven million flasks (more than one-quarter million tons). The past production of mercury throughout the world indicates that a great quantity has been used, and much of it has undoubtedly found its way into the environment.

Agricultural uses of mercury in the form of methylmercury dicyandiamide and other organic mercurial compounds began during World War II in Sweden despite rising complaints from conservationists that birds were dying from either eating treated seeds or from eating rodents which had eaten the seeds. Complaints of mercury contamination and indications of mercury concentrations in fish led to research on the accumulation of mercury in various organisms.

This research indicated that the rates of accumulation in fish varied significantly between different organs and under different conditions. For example, the highest accumulation rates for pike were found in the liver and kidneys. It was also learned that methylmercury is more readily accumulated by fish from food than methozyethel mercury and that for fresh water fish the uptake of inorganic mercury from food seems to be negligible.

Research has also indicated that fish which have accumulated mercury may later eliminate the mercury from their systems. The level of mercury in fish appears to follow the level of mercury in the water in which they live.

A report on fresh water fish from Lake Erie and the St. Clair River indicated the following levels of mercury, based on wet weight for the edible portions:

Walleye pike	1.4 to 3.57 ppm
Sucker	0.88
Northern pike	0.64
White bass	0.53 to 0.80
Channel catfish	0.32 to 1.8
Coho salmon	0.24 to 0.96
Carp	0.08 to 0.28

From such research it is apparent that mercury is widespread throughout the environment. Mercury vapor was, of course, an original component of Earth's atmosphere. Earth itself apparently has an average minimum background content of mercury of about 0.04 ppm in areas which are away from inhabited or anomalously high areas due to metal ores.

Despite the established widespread presence of mercury in trace quantities in the earth and in nature, and despite its various scientific and industrial uses, there have been few cases of record involving mercury poisoning of people.

The most extensive mercury poisoning cases seem to have occurred in Japan where fish constitutes a major element of the popular diet. One series of 110 mercury-poisoning cases attributed to mercury content of fish occurred between 1953 and 1960 in Minimata, Japan, on the island of Kyushu. The waters of Minimata Bay were found to have been contaminated by methylmercury waste water discharges from a plastics manufacturing plant. Fishing in the area was banned and waste water treatment facilities were installed at the plant. A second series of poisonings occurred in 1965 in Niigata, Japan, on the island of Honshu. One hundred twenty persons showed one or more symptoms of methylmercury poisoning, 26 were officially classified as mercury poisoning cases, and five of these resulted in death. The industrial plant to which the discharges were traced was closed.

One case involving a farming family in Alamogordo, N.M., which occurred early in 1970, has received considerable publicity, The Huckelby family ate pork which inadvertently had been fed granary sweepings which were believed to have been treated with mercury antifungal compounds.

Concern for the impact of mercury on human health and economic welfare has led to a proliferation of research effort to determine the major mercury polluting sources. Industry, of course, is the biggest user of newly mined mercury, and it immediately came under scrutiny. Agriculture also was suspected because it contributed by placing mercury compounds directly into the environment as fungicides and pesticides.

Past discharges of mercury with waste waters have accumulated mercury in river silts from which microorganisms convey it as methylmercury into the food chain. With severe restriction of waste discharges containing mercury, existing concentrations will, with the passage of time, tend to become more widely distributed and dissipated over the total environment, thus gradually reducing levels in any one area.

Bringing the mercury pollution problem into focus has brought to attention problems of other toxic materials. As industrialization continues, more and more toxic elements--both naturally occurring and man-made--will be presented to the populace. If their dangers to man and the environment are not thoroughly understood, proper pollution abatement efforts cannot be instituted.

Day 10: Reading--"Chemical Pollutants" and "Persistence of Pesticides Endangers Human Life"

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Dozens of complicated chemical compounds, used to control harmful organisms which attack humans, animals, and crops, have become the center of one major battle to save the environment. The best known of these compounds is DDT, credited with virtually eliminating malaria and typhoid among American soldiers during World War II and with saving billions of dollars of crops from destruction by pests since then. Less commonly known are numerous other pesticides, herbicides, and fungicides also in widespread use in this country and throughout the world.

In a widely publicized move, Secretary of Agriculture Clifford M. Hardin announced on November 20, 1969, that registrations would be canceled for four uses of DDT--on shade trees, tobacco plants, in or around the home (except for control of disease carriers), and in marshes (with an exception for disease control, as determined by public health officials). Other crops would not be effected by the order.

A major lawsuit, brought by a group of environmental organizations, has challenged the use of the herbicide 2, 4, 5-T, at one point widely used as a defoliant in South Vietnam.

In June 1969, the Interior Department banned 16 substances, including DDT, 2, 4, 5-T, and several other controversial compounds from the use on more than 500 million acres of land it controls. Another group of pesticides and herbicides was classified as "restricted" for use when nonchemical uses proved inadequate for small-scale applications.

A number of states have implemented their own restrictions on the use of DDT and other pesticides. But on the federal level, lengthy appeal procedures on proposed restrictions and in lawsuits and conflicting positions between various departments and agencies slowed down action, yet to date DDT has not been completely banned.

Dichloro-diphenyl trichloroethane (DDT), the insecticide which revolutionized crop protection and insect control after experimental use during World War II, was first synthesized in 1874 by German chemist Othmar Zeidler. In 1939 Swiss scientist Paul Mueller determined that DDT was an effective insect killer. In 1948 he received a Nobel Prize for the discovery. Since 1945, when DDT was first marketed commercially in the United States, more than 900 different chemical pesticides have been developed.

Most of the chemicals fall into one of three classes--the chlorinated hydrocarbons, including DDT; the organic phosphates; or the carbamates--all of which include insecticides, fungicides, herbicides, and plant growth regulators. Other chlorinated hydrocarbons were also developed in the 1940s, but the high toxicity, long period of potency (10 to 20 years) and low cost of DDT made it the most popular insecticide through the early 1960s.

During World War II, DDT was tested and declared safe for human use. The small quantity of the insecticide available to Allied troops was used in programs to combat lice and to control typhoid and malaria in the South Pacific.

After the war, DDT rapidly gained a reputation as a panacea for insect problems. Production in the United States grew from 20 million pounds in 1948 to 145 million pounds in 1958. The price of the chemical dropped from $1.19 a pound shortly after its discovery to 17 cents a pound by 1968.

But reports of insect resistance, the availability of other pesticides, and uncertainty over the effects of a steady buildup of DDT on the environment contributed to a decline in the use of the chemical after 1963. Economic Research Service surveys indicate that U.S. output of DDT in 1969 was approximately 40 percent less than the peaks reached in 1960 to 1963.

As DDT production dropped, the use of other chlorinated hydrocarbons, including dieldrin, aldrin, and endrin, and of organic phospate and carbamate pesticides increased rapidly.

The organic phosphates, developed in the 1930s after German chemist Gerhard Schrader discovered their potential as insect killers, were not widely used until the 1950s. Among the highly poisonous organic phosphate pesticides, some of which are deadly to man, are parathion and malathion. Their periods of potency and those of carbamate pesticides, measured in weeks or months, are much briefer than those of DDT-related chemicals, lessening the danger of long-term environmental contamination.

As the new synthetic insecticides became more popular, pesticide sales in the United States soared from $40 million in 1939 to $300 million in 1959. By 1968, annual sales had approached $1.7 billion, and projections in a 1969 Chemical Week magazine report indicated that by 1975, $3 billion worth of pesticides are expected to be produced and sold annually by American companies.

Large amounts of DDT have been used in the United States to protect food, cotton, and tobacco from pests, to control mosquitoes and bats, and to eradicate house and garden insects.

R. G. Van Buskirk estimated in Farm Chemicals in July 1969 that DDT had prevented 500 million illnesses and saved 25 million lives during almost 25 years' use in disease prevention.

Cases of malaria in the United States dropped from a reported 60,000 in 1942 to fewer than 2,000 a year by 1950, largely as a result of DDT insect carrier eradication programs.

In the 1950s, the federal government launched large-scale insect control programs, utilizing DDT to destroy pests threatening farm products, shade trees, and human beings. Major programs attempted included campaigns against the gypsy moth, the Japanese beetle, Dutch elm disease, and the fire ant. The campaigns met with mixed success. They drew loud complaints from conservationists that application of the pesticide was frequently careless and ill-timed, and that DDT was destroying as many birds and animals as it was insect pests.

DDT's effects on crop production, however, rated a much more positive response: the yield per acre of corn and of rice almost doubled between 1947 and 1966. Cotton production during the same period increased from 279.6 to 499.8 pounds per acre, largely as a result of the DDT boll weevil eradication program, according to agricultural chemist G. K. Kohn.

An increasing quantity of the DDT produced in the United States, about 70 percent, is being purchased by AID and UNICEF for foreign malaria programs, and for disease eradication programs under the auspices of the World Health Organization. More than 90 million of the 125 million pounds of DDT produced in the United States in 1968 were sold abroad.

Environmental scientists evinced concern about dangerous side effects of pesticides soon after DDT was marketed, but early government studies revealed no human health threat.

Other chlorinated hydrocarbons, which attack the nervous system via a mechanism not entirely understood, have been fatal to men when absorbed through the skin or swallowed. DDT, least potent of the group, is not. But aldrin, for instance, is so deadly that an aspirin-sized pellet can kill 400 quail, biologist Rachel Carson reported in Silent Spring, published in 1962.

The organic phosphates and carbamates, most of which are highly poisonous to man, cause nerve impulses to flash in increasing intensity until tremors, convulsions, and death result. They may also enter synergistic reactions in which residues of two relatively harmless pesticides combine to form a third deadly compound.

Between 1964 and 1968, more than 1.9 million fish were killed by pesticide pollution in U.S. waters, according to the U.S. Bureau of Sport Fisheries and Wildlife.

DDT defenders claimed its association with fish and bird kills was purely circumstantial. But scientists have demonstrated that by a process called biological magnification, minute quantities of the pesticide absorbed by plankton or tiny insects could be transferred via the food chain in constantly increasing quantities to larger birds and animals feeding on the tiny carriers.

Reproductive failures and near extinction resulted in some bird species, including bald eagles, peregrine falcons, brown pelicans and Bermuda petrels, in which DDT apparently interferes with the egg-laying mechanism, creating thin-shelled eggs. Fish whose larvae are killed by DDT stored in the yolks of their eggs have also suffered reproductive failures.

In man, clinical studies have demonstrated correlations between high DDT levels and cerebral hemorrhages, liver diseases, and stomach disorders, according to California scientists. DDT has also been linked to tumor growth in mice. A University of Miami medical school study revealed that human victims of cancer contained more than twice as much DDT in their fat as did victims of accidental death.

Stanford University biologist Paul R. Ehrlich wrote in 1969 that DDT absorption by oceanic plankton, which produce much of the oxygen in the atmosphere, could cause an even more serious problem; death of the plankton due to pesticides could result in the end of ocean life and a shortage of oxygen to breathe.

Despite the benefit of using powerful pesticides such as DDT to control diseases, there is no doubt of their serious interference in numerous food chains and ecosystems, causing death and deformities among various wild animal species. It is imperative that our governments order an orderly reduction in the production and firm restrictions on the use of any dangerous and persistent pesticide.

Day 11: (alternative reading)--"The Population Explosion" and "Spacecraft Earth May Be Crowded Beyond Capacity"

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> Too many cars, too many factories, too much detergent, too much pesticide, multiplying contrails, inadequate sewage treatment plants, too little water, too much carbon dioxide--all can be traced easily to too many people.
>
> --Dr. Paul R. Ehrlich, The Population Bomb

> Our spacecraft called the Earth is reaching its capacity. Can we not invent a way to reduce our population growth to zero? . . . Every human institution . . . should set this as its prime task.
>
> --Dr. Lee A. DuBridge, science advisor to the President, November 23, 1969

World population is increasing at a geometric rate. In 1970, there were 3.5 billion persons. It took until 1830 for world population to reach 1 billion, but only another 100 years to double to 2 billion. At the current rate of population growth of 2 percent a year, there will be almost 7 billion persons alive at the turn of the century, doubling to 14 billion by the year 2035.

The concern of the government over population is increasing gradually as population growth remains unchecked. In 1959, President Eisenhower said he "could not imagine anything more emphatically a subject that is not a proper political or governmental activity or function or responsibility" than family planning.

In 1969, President Nixon urged as a national goal "the provision of adequate family planning services within the next five years to all those who want them but cannot afford them." In his first presidential message devoted entirely to the population question, he said population growth was "one of the most serious challenges to human destiny in the last third of this century."

U.S. population policy at first focused on population growth as a hindrance to economic growth for developing countries or upward mobility for the poor. Increasingly, concern has broadened to include fears that the industrialized nations, while not facing immediate disaster, will not be able to support their projected populations at the accustomed standards of living.

The Committee of the National Academy of Sciences--National Research Council (NAS-NRC) warned in 1969 that in its judgment, "a human population less than the present one would offer the best hope for comfortable living for our descendants, long duration for the species and the preservation of environmental quality."

The NAS-NRC Committee on Resources and Man found that foreseeable increases in food supplies limited Earth's ultimate carrying capacity to about 30 billion persons, maintained for the most part at a level of chronic near starvation. Predictions that increases in production of food from the sea would solve the population problems were ill-founded, said the committee, estimating that maximum yield from the sea would be about 2-1/2 times the current annual production of 60 million metric tons of fish.

The committee warned that food supplies were only part of the problem. Known and prospective reserves of many substances considered essential for industrial society would be nearly exhausted and by the end of the century, the committee predicted, among them mercury, tin, tungsten, and helium. The committee said it was not certain when other metals, mineral fuels, chemicals, and construction materials would run out, but that increases in demand for these nonrenewable resources could not be satisfied indefinitely. Technology cannot create raw materials although it could postpone their exhaustion.

The NAS-NRC committee's predictions are temperate in comparison with those of gloomier prophets. Dr. Paul R. Ehrlich, professor of biological sciences at Stanford University, for example, says that widespread famine between 1970 and 1985 already is inevitable. "Hundreds of millions of people are going to starve to death unless plague, thermonuclear war, or some other agent kills them first," he said. "Many will starve to death in spite of any crash programs we might embark upon now. And we are not embarking upon any crash programs."

For the United States, which is expected to have a population of 300 million by the century's end, the prime concern is not imminent famine. Many scientists do, however, foresee a steady degradation in the quality of land, air, and water as well as the overburdening of social institutions. They argue that population growth in the United States is in fact a more serious problem than for poorer countries which do not use so many resources.

Conservationists such as former Secretary of the Interior Stewart L. Udall note that the United States, with only 6 percent of the world's population, uses between 35 and 50 percent of the world's annual consumption of nonrenewable resources. Many experts believe about half the current U.S. population of 200 million would be the optimum level for this country in relation to resources.

Dr. Jean Mayer, Presidential advisor on nutrition, wrote in the summer 1969 issue of the Columbia Forum that the major American nutrition problem is overweight, and the major agricultural problem mounting production. But he asked, "Does anyone seriously believe this means that we have no serious population problem?"

Mayer said excellent human beings would not be produced without an abundance of cultural as well as material resources, or without sufficient space. He said a rational policy might entail a decrease of the population as the disposable income rises.

As evidence of the demand placed on the environment by a rich and increasing population Mayer cited:

(1) An increase of 120 percent in visitor-days to state parks while population was increasing only 20 percent between 1950 and 1960

(2) Annual production of 48 billion rust-proof cans, 26 billion nondegradable bottles, 9 million cars, trucks, and buses, 8 billion pounds of nondegradable plastics and a billion pounds of paper

(3) Shortages of drinkable water, not because of increased fluid consumption, but because people are using more water for air-conditioning, swimming pools and expanded metal and chemical industries.

Believers in the population crisis call for a change in the American attitude toward growth, saying the "frontier psychology" which calls for more people and more goods must be replaced with a recognition of the limits of expansion.

Garrett Hardin, professor of biology at the University of California (Santa Barbara), told the House Government Operations Subcommittee on Conservation and Natural Resources in 1969 that the gross national product, perhaps the most popular economic measure, is "dangerously misleading." He criticized the GNP for including needless luxuries such as gambling and tobacco and the costs of cleaning up pollution that should not have occurred in the first place.

Hardin proposed creation of a new economic measure to be called "net national amenities," which would take into account only the things that "contribute positively to human well-being." He included food, shelter, entertainment, access to quiet places, and uncluttered surroundings among the amenities.

Open space may be a psychological necessity for human beings. Studies of animals have found that lack of space can lead to serious behavioral aberrations. Mice crowded together in the laboratory have become nervous and aggressive. Their actions include murder, sexual deviations, and inability to care for their young. Drawing parallels with the lower animals, some demographers and urbanologists cite increasing urban crime, homosexuality, and child abuse as evidence of the effects of overcrowding on humans.

Some experts do not believe there is a population crisis in the United States. Ben J. Wattenbert, a demographer, challenged the assumptions of pessimistic predictions about the population growth in an April article in The New Republic. He said that America was not by any new standard a crowded country, that population growth will not necessarily be harmful, and that the publicity given to a nonexistent population crises diverts attention from the vital issues of the war and the cities.

Wattenberg noted that in terms of relative density the United States is a sparsely populated nation. The United States has a density of 55 persons per square mile, 18 times less dense than Holland and 10 times less dense than England. He said the United States had been experiencing a population redistribution, rather than a population explosion, in recent years, with movement to the suburbs the dominant feature of the change.

Wattenberg noted that the American birth rate is declining. Since 1957, the end of the post-war baby boom, the fertility rate has gone steadily down, from a high of 123 babies born per thousand women aged 15 to 44, to 85.7 in 1968. He suggested the birth rate could fall more if there were a business recession, recalling that during the depression, fertility rates fell to 76.

Wattenbert claimed that population growth, by increasing tax revenues, could increase the available government funds for pollution control. Defense spending would remain constant with a higher population, according to his analysis, as would the costs of cleaning up the environment.

As for nonrenewable resources, he said these will run out some time by definition and a substitute will have to be found. Rich persons do not present more of a threat to resources, he said, because they have fewer children than the poor. Wattenberg cited a 1964 census survey that found that among women who had completed their childbearing years, families with incomes of $10,000 and over had 2.21 children, or only slightly more than the 2.13 currently needed to replace the population. He said it was possible that affluent persons who have not yet completed their families might even have fewer children and barely replace themselves.

Other population experts say a population problem exists in the United States but has been oversold. Dr. Philip M. Hauser of the University of Chicago told an American Medical Association congress on environmental health in May that by bombarding people with predictions of impending doom, environmentalists were breeding complacency. When the predictions proved false, he said, people would be less apt to believe sober forecasts of the real problems which still lay ahead. Elimination of unwanted births would alleviate problems for all economic classes, but especially for the poor.

A study by Charles F. Westoff, professor of population research at Princeton University, found that from 1960 through 1968, between 35 and 40 percent of the natural increase in U.S. population could be attributed to unwanted fertility. Thus, prevention of unwanted births might be expected to contribute considerably to a lessening of population growth.

But the poor, who want about the same number of children as the nonpoor, are less able to support an extra child and have less access to family planning services. HEW statistics show the average number of children wanted by a wife is between 3.2 and 3.4, from the five million poor women who need family planning aid and are receiving help in preventing births to the richest women.

Birth control has been called an attempt on the part of rich whites to control the number of the poor and blacks. But family planning services are nonetheless eagerly received where they are available.

Mrs. Bobby McMahan, representing the National Welfare Rights Organization, told the Senate Health Subcommittee in 1969 that "many black people feel that government officials who support family planning services are doing it in hopes of reducing the number of poor . . . particularly the black poor . . . . On the other hand, the poor are not going to cut off a nose to spite a face, whatever the real motives of you legislators may be."

Publicity given to the possible bad effects of the most popular existing contraceptive has intensified efforts to find a safe and effective alternative. The most effective means of birth control yet devised is the oral contraceptive--"the Pill." But the Pill's popularity was dealt a major blow by hearings by the Senate Monopoly Subcommittee on Small Business early in 1970. A Gallup poll completed during the hearings, chaired by Senator Gaylord Nelson (D-Wisconsin), found that 46 percent of women surveyed considered the Pill unsafe, compared to 22 percent in 1967. One witness estimated there would be as many as 100,000 "Nelson babies" born in 1970 as a result of the hearings. Witnesses testified that Pill users risked health impairments ranging in severity from mild headaches to fatal blood clots.

The risk of death from blood-clotting disorders, first reported in British medical literature in 1962 and now considered well documented, is three per hundred thousand Pill users. This is approximately 10 times the rate of death from the same cause for nonusers.

Dr. Alan F. Guttmacher, president of Planned Parenthood/World Population, told the Monopoly Subcommittee that pregnancy carried greater risks than the Pill. Nor, he said, was there an acceptable substitute for oral contraceptives. Intrauterine devices (IUDs) have a failure rate of five pregnancies per hundred users. Other methods have an even higher failure rate.

In the absence of an adequate replacement for the Pill, the FDA advised physicians to prescribe, whenever possible, oral contraceptives containing the lowest amounts of estrogen, the ingredient blamed for blood problems. In line with this recommendation, the FDA is expediting applications for marketing low-estrogen pills.

Modifications in IUD design may make them less risky. IUDs of traditional shape have tended to wander, particularly in women who have never had a child, sometimes perforating the uterus, thus causing bleeding, peritonitis, and even death. New designs, named for their shapes, are intended to stay put. Among these are the "LM," shaped like a lunar module, and the "crab." The addition of copper, zinc, or a hormone to an IUD might increase efficacy and reduce side effects.

More radical birth control innovations already are being tested clinically. Dr. Sheldon J. Segal, director of the biomedical division of the Population Council, told an American Medical Association meeting in May that there were nine new approaches to contraceptive action, including some to be used on the man, being tested on patients.

Government research in contraception is focusing on basic processes of the reproductive cycle. The National Institutes of Health signed contracts in 1969 totaling about $3 million for research in contraceptive development. NIH hopes to find ways of altering the reproductive cycle enough to prevent pregnancy without stopping ovulation altogether or interfering with other body functions. Possibilities offering more convenience will be explored, including a morning-after and once-a-month pill.

Day 12: Reading--"Physiological and Psychological Effects of Noise on Man"

Adapted from Alexander Cohen, "Physiological and Psychological Effects of Noise on Man," Industrial Noise: A Guide to Its Evaluation and Control, A. D. Hosey and C. H. Powell (eds.), U.S. Health, Education and Welfare (Washington, D.C.: U.S. Government Printing Office, 1967).

By definition, noise is unwanted sound. Excessive noise can cause hearing loss and other undesired physiological changes, interference in speech communication, some loss in work efficiency, and annoyance. Although noise appears capable of producing such adverse effects, clarification is needed as to the health significance of these various alterations, the levels and types of noise conditions required to produce them, and the mechanisms underlying the specific noise-induced effect noted.

Exposing the ear to an intense noise will most probably cause hearing loss which may be temporary, permanent, or a combination of the two. Temporary hearing loss represents loss in hearing that can occur after a few minutes' exposure to an intense noise and is recoverable following a period of time away from the noise. With daily continuous exposures for months or years to intense noise, there may be only partial recovery of the observed loss, the nonrecoverable loss being indicative of a permanent noise-induced hearing impairment.

Aside from damage to the hearing mechanism, noise conditions found in industry are not considered to produce any other physiological impairments. Recent reports however suggest an association between noise, hearing loss, and cardiovascular disorders, although the relationship is still unclear. Even moderate levels of noise appear to cause constriction in blood circulation. Individuals working under intense noise conditions (e.g., ball-bearing manufacturing plants) showed some functional disturbances of the cardiovascular system, including a slowed heart beat.

Sudden intense noise can cause marked physiological changes, including a rise in blood pressure, increase in sweating, changes in breathing, and sharp contractions of muscles in the body. These changes are generally regarded as an emergency reaction of the body, increasing the effectiveness of any muscular exertion which may be required. Although perhaps useful in emergencies, these changes may be harmful for long periods since they interfere with other necessary activities or produce undue amounts of fatigue. Fortunately, these physiological reactions subside with repeated presentations of the noise.

Intense (or extremely high) levels of sound are capable of causing dizziness or loss of equilibrium since the balancing organs are stimulated. Such high intensity exposures may also cause alterations with other types of sensory behavior and will definitely cause pain, perhaps even traumatic damage in unprotected ears. Examples of such extreme noise conditions are few; possibly in jet engine test cells these high levels would be reached.

The most demonstrable effect of noise on man is that it interferes with his ability to use voice communication. A noise which is not intense enough to cause hearing damage may still disrupt speech communication as well as the hearing of other desired sounds. Obviously, such disruptions will affect performance on those jobs which depend upon reliable voice communication. The inability to hear commands or danger signals due to excessive noise may also increase the probability of accidents.

Contrary to popular thinking, there is little evidence to support the notion that noise degrades performance. Laboratory studies of this problem have shown that tasks involving simple, repetitive operations are not affected by noise. Although efficiency in more complex tasks may be initially decreased by noise, such effects tend to vanish as time and practice on the task increases. There have been reports however which show noise to cause significant losses on vigilance-type tasks. Such tasks require the subject to keep a constant watch over a number of dials or indicators to report changes that may occur on any dial at any time. Noise-related losses in vigilance performance are significant because of their implications for automated jobs which involve the monitoring of control panels with many indicators displaying information about an ongoing machine process. This finding also has practical importance for jobs requiring the inspection of items passing on a conveyor belt.

Perhaps the most widespread reaction to noise is that it is annoying. Whether annoyance types of noise conditions constitute a hazard to health is not known. It has been claimed that residents of communities surrounding airports develop hypertensions, ulcers, undue anxiety, and nervous disorders as a result of the aircraft fly-over noise exposure. These effects however have never been verified. In fact, studies of communities' impact by aircraft noise show complaints to be motivated by factors that do not bear directly on the health of the exposed populations; e.g., interruption in voice conversation (telephone use) and TV reception, and personal grievances against the airport management. Such studies have not included a survey of the health of the residents in the impacted area and thus do not rule out the possibility that physiological or mental-type disorders may stem from such noise conditions.

Noise is annoying to many people for different reasons. The annoyance caused by the intrusion of aircraft noise into communities around airports is based, in part, upon the residents' being fearful that the planes might crash into their homes. Music tolerated during waking hours may be annoying during the hours of sleep. People may complain of the noise made by the neighborhood. The comforts derived from air conditioning outweighs the noise of such units. Similarly, the economic value of nearby plants to a community may offset the noise produced by the plants; annoyance due to military aircraft noise may be offset by the assurance against surprise attack by an enemy. Some individuals complain about all kinds of noise as well as other types of nuisances. As for the stimulus itself, there appear to be some basic characteristics of sound which can be considered as more annoying than others. These characteristics are as follows:

(1) Loudness--The more intense and consequently louder sounds are more annoying.

(2) Pitch--A high-pitch sound, i.e., one containing high frequencies, is more annoying than a low-pitch sound of equal loudness.
(3) Intermittency and irregularity--A sound that occurs randomly in time and varying in intensity or frequency is judged more annoying than one which is continuous and unchanging.
(4) Localization--A sound which originates from several sources or locations is less preferred than one which originates from a single source.

To summarize, adverse effects of noise on man include temporary and permanent hearing loss, speech disruption, loss in performance capacity, and annoyance. Factors believed critical in evaluating a potential noise hazard to hearing are the overall level of the noise, total exposure, duration, time and frequency distribution of short-term exposure period, and susceptibility of an individual's ears to noise--including hearing loss.

Day 13: Reading

Adapted from U.S. Department of the Interior, Man: An Endangered Species? Conservation Yearbook no. 4 (Washington, D.C.: U.S. Government Printing Office, 1968), pp. 7-16.

Man is a threatened species. The twin spectors facing him are overpopulation and unbridled technology, both self-induced. The double threat is aimed most directly at man's environment. As the United States strives to accommodate more human beings than ever before, increased demands are placed on our natural resource bank. Our surroundings become increasingly crowded, noisy, and soiled.

The environmental squeeze from technology and population pressures is more than the mere loss of mineral reserves, air and water quality, and forest resources. These are losses that can be measured--in used tons of ore, in coliform bacteria count, in felled board feet--and these measurements suffice to describe what is happening to the parts of our world we must breathe and drink and feed on.

But we have yet to devise a satisfactory index to measure the diminishing quality, the creeping vulgarity and ugliness, of those environmental components which man must look at, listen to, work with, and play in.

Searching back into prehistory, we find that almost every loss of a life form or species has been caused by one or a combination of three things: intensive specialization leading to an evolutionary deadend, geological or climatic forces which proved catastrophic, or some other form of fatally inimical life.

It is remarkable that throughout millions of years of evolutionary struggle toward humanity, the life form which was to become man escaped the trap of specialization. This changing, adapting species with its human destiny managed to maintain its options. Man also survived the environmental elements.

The third threat--from a strain of hostile life--remains a force to be reckoned with. That threat is man himself. Having avoided the fatal turn of the evolutionary road which led other life forms to an overdeveloped hide, a wing, or a fin, man has used his grasping hand and his creative brain to build himself another kind of trap--a technological trap--and he is crowding it with ever-increasing numbers of his own kind.

The question becomes, most urgently: Is man still exercising free choice--that one absolute necessity--if he is to avoid the fate of the dinosaurs and the dodos?

Buffeted by the elements and beset by other life forms, man has always stubbornly insisted on exercising every option open to him. Does he still run his own show today? Or has he finally stumbled upon two forces--population and technology--that he considers too sacred to tamper with? Is he still convinced that the roaring crescendo from babies and bulldozers is the sweet music of progress?

Does he confuse technology with science? Will he continue to accord to the jackhammer the same revered status as the test tube? Or will he recognize in time that the tools he uses to rip up mountains and destroy estuaries must be extensions of his mind as well as his muscle? Will he see that science must remain free, since it is the search for truth, but that technology is only a means of applying truth--and that these applications need the control and balance of wisdom and a concern for posterity?

Man stands at a fork in his environmental road to the future. The two arms of the signpost do not state categorically, "Man--Master of Himself" and "Man--An Extinct Species," but it is increasingly apparent that the direction he takes now will move him rapidly along the path toward one or the other destination.

Let us look closely for a moment at this creature who pauses at the crossroads and clamors for attention with his own voice. Who is he? Where has he come from and how has he made the journey this far? Anthropologists tell us he is the product of millions of years of evolution--his being literally shaped by the environment without and the life force within. During all these eons he fought a pitched battle for survival. His attitude toward nature was understandably ambivalent, for nature was his best friend and his worst enemy.

In the beginning, his progress was agonizingly slow, his survival often in doubt. But with the passage of the ages and with a cunning constantly sharpened by the struggle for survival, man established himself at the top of the totem pole of life. He went from flint and flame to rocket-powered flight, with ever-increasing speed, until he had created a veritable juggernaut against nature and, in so doing, against himself. Now that he has forced the lock on Pandora's nuclear toolbox, his capacity to tamper with his environment and his destiny is virtually limitless.

Today, the most significant thing about change is the speed at which it is occurring. The acceleration rate of tooled tampering with our environment is in the nature of a nearly vertical line on the chart of time. Its path is almost straight up--its destination out of sight.

We are in desperate need of guidelines, but too often our steering apparatus is geared to a tomorrow projected off on a horizontal time-line from today. In reality, when tomorrow becomes today, it will probably be breaking somewhere far over our heads instead of off to one side.

We cannot alter the past. At current speeds, the present becomes the past even as we set hand to it. At such speeds, our options for today are drastically narrowed. Only tomorrow can be dealt with. The technology to shape tomorrow is in our hands. What is still needed, and urgently, are the social and political means of giving intelligent direction to the awesome tools we have fashioned.

The speed of change has introduced a new danger--the increasing role that chance plays in our human society and its interactions with the natural environment. Man's adaptability, which allowed him to make the dangerous passage from the world of the merely organic into the world of thought, "shorn of fangs and fur and claws" as the poetic anthropoligist Loren Eiseley puts it, is today being sorely taxed as it tries to cover the expanding range of choice.

Says Professor Eiseley: "Choice, even intelligent choice, becomes increasingly hard to make among an infinite number of diverging pathways, some of which show signs of leading into new and dangerous corners."

The late Robert Oppenheimer, a physicist, wrote: "One thing that is new is the prevalence of newness, the changing scale and scope of change itself, so that the world alters as we walk in it, so that the years of a man's life measure not some small growth or rearrangement or moderation of what he learned in childhood, but a great upheaval."

Professor Eiseley put the same idea this way: "I myself, like many of you, have been born in an age which has already perished . . . . I will not be merely old; I will be a genuine fossil embedded in onrushing man-made time before my actual death."

The warning is clear. While we indulge in worthy, earnest, but nevertheless limited enterprises such as saving the whooping cranes, we fail to notice our own growing eligibility for the title "endangered species." The terrible urgency of accelerated change as a focus for intensive application of human brains is summed up in the phrase "technological momentum."

Admiral Hyman Rickover told a 1966 meeting of the Royal National Foundation in Athens, Greece:

> If people understood that technology is the creation of man, therefore subject to human control, they would demand that it be used to produce maximum benefit and do minimum harm to individuals and to the values that make for civilized living. . . . Unfortunately there is a tendency in contemporary thinking to ascribe to technology a momentum of its own, placing it beyond human direction or restraint . . . a tendency more pronounced in some countries but observable wherever there is rapid technological progress.

We have, no matter how dimly we perceive it, a moral obligation to the future. Kenneth Boulding, the economist, has observed that it is always hard to find a convincing answer to the man who asks, "What has posterity ever done for me?"

"The whole problem," Boulding maintains, "is linked up with the much larger one of the determinants of the morals, legitimacy, and 'nerve' of a society, and there is much historical evidence to suggest that a society which loses its identity with posterity and which loses its positive image of the future loses also its capacity to deal with present problems, and soon falls apart."

In a world which is essentially (with the important exception of solar energy) a "closed system," our primary considerations are those of extraction and waste disposal. As we extract our natural resources, we diminish them. As we dispose of waste products, we contribute to pollution. Ironically, it is the waste rather than the supply problem that demands our prior attention. With air and water in many places exhibiting signs of intolerable overload, this question of waste disposal has become one of the prime threats to human survival. The attempts being made today to remove man from the endangered list are aimed in large measure at this threat.

Economist Boulding is hopeful that "as a succession of mounting crises, especially in pollution, arouse public opinion and mobilize support for the solution of the immediate problems, a learning process will be set in motion which will eventually lead to an appreciation of and perhaps solutions for the larger ones."

Earth has been likened to a spaceship on which man must carry all his needs and live with all his waste products. It is within this closed-system context of our predicament that we must consider our pollution problems. Again, we find science a mixed blessing, for while we can be fairly sure of discoveries that will lead to new ways of supplying needed materials and energy, these new supplies lead to new waste problems, such as the insidious and inadequately charted contamination from man-released radioactive materials.

As we crowd more and more people into the spacecraft (and population growth becomes "exponential" when it is significantly freed from such checks as disease), we face an eventually impossible situation but one that carries some tragic possibilities on the way to the ultimate impossibility.

Rene Debos, in an essay on "Environmental Quality in a Growing Economy," says that "the problems posed by adaptation to crowding bid fair to change in character and to become of increasing importance in the near future . . . . Furthermore, experimental studies with various animal species have revealed that excessive crowding results in many forms of behavioral disturbances, ranging from sexual abberrations to cannibalism or . . . more interestingly to complete social unresponsiveness."

Thus the question of whether we are to survive on this planet at all becomes not just one of controlling the birthrate but of whether, along the way to the critical mass of humanity, we create conditions that will make existence nearly intolerable. It has been noted that the only question with relation to the future of world population is whether the inevitable decline in rate of growth will come about through a tremendous upsurge in the death rate or through a drastic fall in the birth rate. Over the long haul, these two solutions represent our only choice. The latter, a fall in the birth rate, will represent unprecedented human wisdom.

The problems created by thoughtless growth in some areas of technology are sometimes compounded by lags in other areas. There has been, for instance, a regretable lack of technological activity in solving air pollution where our problems are chronically aggravated by an automobile whose internal combustion system has hardly progressed since it was adopted. A true pursuit of technological improvement might well have solved the exhaust pollution problem long before it became the near tragedy it is today.

It is generally conceded that we have now, or know how to acquire, the technical capability to do nearly anything we want to do. Possessing such capability (and here it is well to draw a parallel distinction to that between science and technology, the distinction between capability and wisdom), we have a duty to shift the emphasis far more heavily from how it can be done to whether it should be done. This is the central question facing modern conservation. With so many humans inhabiting the environs, and with such powerful tools for shaping the environment, where should we move ahead, where should we hold back, and what directions should we take?

We must start by rejecting what we cannot do. Walter Sullivan, science columnist for the New York Times, wrote on March 25, 1967: "In a world of proliferation--proliferation of human beings, of nuclear weapons, of food additives--unplanned, uncontrolled technological growth can no longer be tolerated. . . . The world has become too dangerous for anything less than utopias."

We are not likely to find many utopias lying around tied up in neat packages of total solutions. Our main hope is that we are beginning to understand the totality of the problem of survival. The threats to this survival are woven in a skull and crossbones pattern into the fabric of our entire world; it crisscrosses the boundaries between the social and the natural. We cannot continue to exist if we do not take care of our natural world, and we cannot exercise the life-or-death brand of stewardship required without massive exercise of wisdom at the social level.

The time span remaining for constructive action is short. The future slips into the past at a blurred clip and our hope lies with those whose vision is as wide as the problem and whose courage is a match for the corrective measures so urgently needed.

What is called for is some sort of concerted effort in every segment of our society. Whether those involved are sociologists, economists, forester, agronomists, biologists, public office holders, or private corporate decision makers, their minimum mutual goal is the meaningful survival of man and his planet. A more ambitious objective would be to fashion for tomorrow a world we think we ourselves might be happy to inhabit. There are hopeful signs that we may not just survive, but that we might even enjoy it.

In the past, as the idea of conservation grew, we intended to separate our environment into its components--forests, wildlife, minerals, soil, water--and to deal with each separately. This piecemeal approach has proved inadequate. As we dealt with the various parts of the periphera, the core of the problem--which is mindless tampering with the environment--was creating new problems all over the surface. So profound and all-pervasive are the effects of exploding population and expanding technology that efforts to deal with environmental problems are unlikely to be effective in a long-term sense unless we turn our attention to these two root factors.

Conceivably, this could be the Planet of Eden without man. Nature could go back to keeping her own tempo. Lakes would appear and die, their aging processes unhurried by human wastes, keeping time to the leisurely beat of the life symphony as it was before men and machines changed the score. Mountains would wear down gradually from wind and water, without the swarming action of the bulldozer, power shovel, and the blast of explosives. The air would revert to the tenancy of birds, whose population balances would shift into harmony with a world shorn of such civilized graces as pesticides and pavement.

Our remaining minerals and fossil fuels would lie untouched in their cradles in Earth's crust. The underground fires in abandoned coal mines would wink out, one by one, and the scabrous mountainsides would pull a healing bandage of brush and trees over their strip-mine scars and settle down to the gentler touch of the ages. But this kind of ending to environmental mayhem would be meaningless--to us at least--if man were dealt out of the picture.

There are other ways to sanity in the natural world. Conservation requires man to have meaning; it does not require an end to the technology which serves man--in many cases extremely well. What it does mean is that man must exercise control--over himself first, and then over his tools.

Man requires wood, but he has learned that he can take the trees and spare the forest. He must extend this insight to include consideration for recreation and scenic and historic values as he supplies his need for wood fiber. Man requires fresh water. He has learned that he can treat his wastes before returning them to the waterways and thus extend the usable life expectancy of his stream system. He has still to learn how thermal pollution affects the plant and animal life of his waters, how to protect his vital estuaries so that he does not break the chain of marine life in favor of ill-considered human developments, how to draw water from the clouds that now react only to the whims of weather.

Logging, fishing, farming, grazing, swimming, boating, housing, manufacturing--all these activities directly involve our natural resources and our lives. As men proliferate, they find these necessary human activities coming more and more into competition with one another. The logger and the nature lovers rub against each other's grain. The estuarine developer serves the homeowner but destroys the fisherman's living. The manufacturer may raise our indoor living standard while he kills an entire river with his deadly chemical wastes.

As man and his machines come to grips, the environment is caught in the squeeze. The resulting distress signals have not gone unheeded. The unmatched conservation record written by recent Congresses is an apology to the past and a pledge to the future. It faces up to our vanishing open spaces, our murky air and dying waters, our shrinking resources and endangered wildlife. It is a bread and butter letter to our environment. And it demonstrates that a nonpartisan conservation conscience is part of the body politic--shared by men and women of every political coloration.

The conservation task, with all its contradictions and urgency, demands a world view and the highest wisdom, courage, and energy we can accord it. More and more of our most highly educated, deeply motivated men and women are electing to spend their talents in building a better environment. Their work seldom makes headlines; it is content to make a world.

Day 14: Reading--What You Can Do

Adapted from U.S. Department of the Interior, "Conservation in Action," It's Your World: The Grassroots Conservation Story (Washington, D.C.: U.S. Government Printing Office, 1969), pp. 91-95.

Burrow awhile and build; board on the roots of things.
--Robert Browning

While blight and pollution and resource-stripping continue to pile environmental insult upon injury, the conservation movement "burrowed awhile" and developed a broad root system. All over America, people who never considered themselves environmentalists or ecologists, or even conservationists, began to wrinkle their noses, rub their eyes, hold their ears, and wonder what was happening to their land. Their wonder grew, and turned to alarm. They sensed through every warning system an increasingly sleazy world. And then, first by ones and twos, and then by hundreds and thousands, they rebelled against the cheapening process. On this grassroots foundation of awareness, rebellion, and yearning, conservation is astir and moving. The burrowing time is past; the building time is here.

Former Secretary of the Interior Stewart J. Udall on May 7, 1968, in an address before the White House Conference of the Advertising Council, suggested that the meek may not care to inherit the earth "if the pace of our pillage continues to grow." Even the meekest, however, were already taking up the challenge. Everywhere they were bent to the task of improving their inheritance. The following is a necessarily sketchy, but representative litany of their works.

An energetic citizen of Illinois, Ralph Frese, helped organize a massive canoe trip down the lower Fox River for the attorney general of that state and 60 persons in an effort to enlist aid in protecting the few free-flowing scenic rivers left in northern Illinois. Frese brought the decision makers to the site and put them afloat. "After that," says Frese, "I let the river tell my story."

The Maple Creek Improvement Association of Seattle got together in 1963 to battle for preservation of their tranquil, wooded enclave, wedged between two traffic-clogged main streets. They won the fight to keep the city from straightening and widening the road through their serene section, and have since stayed organized to fight off intermittent threats--such as the dumping of garbage and dirt into the wild ravine that backs most of their homes. The gainers? Seventeen families, assorted raccoons, squirrels, pheasants, ducks, at least one owl, and the city of Seattle.

The Boy Scouts of America in 1968 updated the requirements for their Conservation of Natural Resources Merit Badge to meet the changing ecological nature of the new conservation. The merit badge revisions recognize the need to end the patchwork approach to our environment and to consider Earth as an interlocking whole.

In July 1968, nearly 300 Camp Fire Girls of high school age converged at Estes Park, Colo., for a four-day focus on natural resources caught in the crosscurrents generated by concerned industry, government, and private and civic groups. In groups of 30, the girls then dispersed to various target areas for 12 days of on-the-spot discovery. They returned to Estes Park to examine their findings--to achieve a responsible, balanced approach to conservation, use, and preservation of natural resources.

Youngsters in Park Ridge, N.J., make off-season use of a Pocono Mountains summer camp as an outdoor classroom where they meet nature at the grassroots level. The natural wonderland experience is a week-long event, fall and spring, for Park Ridge sixth-graders. Andrew L. Sim, assistant to the superintendent of schools, says they learn about beavers, how to change the flow of water, the ways of birds. They absorb conservation. "But the key thing is the social value," says Sims. "They learn respect for their world and the other creatures and plants that inhabit it."

In order to dramatize what must be done to save our environment and how technology can be the hero instead of the villain, students of the Institutes of Technology at California (Cal Tech) and Massachusetts (MIT) engaged in an electric car duel in the summer of 1968. Each campus built a fumeless buggy and raced its products to the other's campus.

National conservation groups furnish excellent information on both general and specific areas of conservation concern, to help individual citizens understand all sides of an issue that affects the environment. The Wilderness Society, for example, has about 1,300 "leaders" in communities all over the nation . . . direct, live plugs into the grassroots. When a controversial issue is coming up in Congress, these leaders are provided with information pro and con. The leaders then try, at the community level, to interest other citizens in letting their own views on the issue be known to members of Congress or public officials.

In Jonesboro, Ga., the Women's Club members mounted ladders and painted store fronts for the town's merchants as part of their general beautification plan.

Bonds for urgently needed new sewer and water systems were voted in Basin, Wyo., as a result of a house-to-house educational campaign conducted by the town's clubwomen.

The Community Club of Hockessin, Del., faced outright antagonism along with apathy when it organized the Hockessin Area Development Association, sparking community cooperation in solving problems of blighted areas, sewage and water, zoning and recreation, and other needs. The club won the $2,000 fourth prize in the 1968 Community Improvement Program competition sponsored by the General Federation of Women's Clubs.

Some people's "individual grassroots action" consists in speaking out on problems where they have special professional competence. Dr. Garrett Hardin of the University of California, who possesses such competence in the area of "supersonic boom," was quoted on the national press service wires in the spring of 1968 as saying: "Experiencing it is like living inside a drum beaten by an idiot at insane intervals."

Apparently some determined citizens share Dr. Hardin's view of this kind of "progress." A Citizens League against the Sonic Boom, headquartered at 19 Appleton Street in Cambridge, Mass., is concerned with the physiological and psychological effects of the boom on humans and wildlife.

In California, a single nonprofit organization called the Planning and Conservation League was formed in 1964. Two dozen persons, representing many of the most powerful conservation and planning organizations in the state, joined forces for a single, full-time, sophisticated lobbying effort to achieve state legislation in the planning and conservation field. Their story was told in the New York Times on March 17, 1968, by William D. Evers, who noted that "certain important maxims can be derived from the successful experience of the PCL." They are:

(1) Organize statewide.
(2) Have an executive committee consisting of architects, planners, lawyers, businessmen and conservationists who are not idealistic "dogooders," but a coalition of professional people who know what is happening in the business and political world.
(3) Involve the experts and anyone with the will to work in the process of forming a legislative program.
(4) Have a good lobbyist.
(5) Concentrate solely on state legislative issues. Hundreds of requests to get involved in local or national issues are received. To respond to them only weakens the state effort and offends other groups.
(6) Follow through from beginning to end on a piece of legislation--this increases the legislators' respect.
(7) Do not introduce wild, far-out schemes--this decreases the legislator's respect.
(8) Raise lots of money.
(9) Go after organizations as members but seek individual memberships as the prime source of financial support.
(10) Find good men who are willing to devote a great deal of time to the cause without compensation.
(11) Keep all members informed.
(12) Let all the members of the legislature know about your program and presence.

Advertisements of large business and industry, which represent a kind of grassroots action at the corporate level, invite and instruct individual citizens to act on their own. "A little town put up a big fight, and now this natural beauty is yours to enjoy" was the theme of a recent "conservation series" advertisement sponsored by a large industry. It tells how "outsiders" tried to drain Georgia's Okefenokee swamp, unaware that the waters were really sweet and pure; how they slaughtered game, hauled out giant cypresses, and generally made the folks in nearby Waycross good and mad.

The townsfolk organized and enlisted the help of Cornell University, the National Audubon Society, the American Museum of Natural History, and others to beleaguer state and federal officials to finally succeed in "getting Uncle Sam to protect Okefenokee" by making much of it a national wildlife refuge. This refuge is now a key part of the system administered by the Department of the Interior. But it represents a giant cooperative effort that started with a small town, its local newspaper editor, Liston Elkins, the Waycross Chamber of Commerce, and the aroused townsfolk who raised $100,000 and got the state to lease back additional land and create a magnificent park.

This and other ads in the industry conservation series are designed to encourage more citizens to help preserve our national heritage. The Institute of Life Insurance is running a similar series which spells out in dramatic detail what has happened to our environment and what some people are doing to help. One advertisement says: "As a start, thousands of suburbanites have gone to East Harlem, and together with local residents, embarked on a face-lifting project to clean, repair and repaint along neighborhood streets. . . ." After listing several more projects, it concludes: "It's up to all of us."

In a very real way, that is what grassroots power amounts to--"all of us." The grassroots represents a vast well of potential good; it awaits only the information to spark intelligent decisions and the discipline to take thoughtful action.

Let no citizen feel he is impotent to effect change in today's crowded world. Everyone is concerned about his own backyard. If all the "backyard conservationists" were to stretch their vision just a little beyond their own boundary fences, America would have a natural conservation task force standing literally at the root of every environmental problem that besets us.

Day 15: Reading, "Technology and the Environment"

Adapted from National Pollution Control Council, U.S. Department of Commerce, The Engineer's Responsibility in Environmental Pollution Control (Washington, D.C.: U.S. Government Printing Office, 1971), pp. 8-17.

We are now at the threshold of an enormous opportunity--to make our country not only stronger and more prosperous but, through the control of pollution and other adverse effects upon the environment, to render it more spiritually satisfying as well.

While concern with environmental problems should be regarded as a healthy manifestation of those deeper human and spiritual values which have guided this nation since its founding, it nevertheless would be an error to blame such problems on technology alone, without taking into account certain of our more "human" failings reflecting attitudes of neglect, want of concern, or simple expediency. More accurately it is the misuse of technology which is at fault rather than technology itself. Any argument to the contrary would be to overlook the myriad of blessings which technology has brought about in the fields of medicine, science, industry, transportation, communications, and countless other areas. Furthermore, it may well be technology itself supported by public and national resolve, which will provide us with our most effective weapon in the solution of environmental problems.

Significant steps already are under way in developing technical mechanisms and processes which will purify our air and waterways, reduce the noise and waste of our cities, restore the beauty of our countryside, and remove the many frustrations that plague the motorist or imperil the pedestrian on our freeways and city streets. Much remains to be done, however. We have penetrated the surface of our problems, and developed the groundwork for future solutions. What now is required is the furtherance and deepening of these efforts, conducted in an atmosphere of genuine cooperation and renewed resolve.

Technological change is occurring at a faster rate than at any time in our history. Demographically, we continue to flock from rural to rapidly expanding urban centers with their enormous social, psychological, and physical challenges. To satisfy the demand of an increasing and more concentrated population, the engineer is called upon to build larger and more numerous power plants, to expand existing oil refineries, to carve out new freeways, to mine additional metals, to build miles of new pipelines, and to help plan entirely new communities, free from the congestion (and pollution) of the old.

Obviously, we cannot halt all such projects in midstream, without calling a halt to man's wants and needs (which would be tantamount to calling a halt to man himself). What is needed, is control. As Glenn Seaborg has put it, "not less technology, but better technology."

An interdisciplinary approach is required, bringing the engineer, planner, architect, social scientist, and legislator together to plan and effect long-range solutions to common problems. In such a way, we may broaden the base from which answers are sought and expand the scope of an undertaking from a single purpose to a multidimensional concept.

In today's context, when we speak of the "standard of living," we are no longer thinking in terms of mere numbers--additional kilowatts, extra miles of freeway, thousands of more automobiles. We now ask ourselves what kind of power plant, refinery, automobiles do we wish to build? What effect will these things have on the environment beyond their proposed function?

Quantity? Yes. But the environmental perspective commands us to look with equal concern on the quality and effect of these undertakings. How do we build without polluting or dislocating the environment? How do we meet man's material needs with a masterful and self-controlled technology? Can we satisfy power requirements and still meet the demands of the conservationist, the nature lover, the canoeist, or the fisherman?

By the year 2000, for example, we may consume as much power in one year as mankind has used since the beginning of the world. In the next 30 years, we will probably build enough homes, offices, parks, and factories to equal the entire inventory accumulated to date on this continent since the arrival of the Pilgrims. Each year two or three million people are being added to the U.S. population alone, while 500,000 acres of countryside are being converted to urban concentrations.

Environmental engineering, because it reaches across many fields, provides the kind of resources, equipment, and organization needed to cope with the complexities reflected in the demands of our public and private institutions and citizenry. Relating this approach to day-by-day professional responsibilities means that the design and construction of a power plant, refinery, papermill, or communications system must no longer be regarded the sole concern of the technical specialist. Nor should the creation of residential or industrial communities be thought of as the exclusive domain of the designer or builder. A new and broader dimension is needed if we are to provide for the effective husbandry of our environmental resources.

Rapid transit systems, the design and construction of nuclear power plants, the distribution of recycling of water supplies, the disposal of waste products through irradiation or their use in the reclamation of substandard agricultural lands, the desalination of sea-water for human consumption--all such undertakings, while basically engineering concepts, nevertheless involve a broad range of related disciplines.

The engineer's experience in using a systems approach to the solution of complex problems and his demonstrated ability to manage machines, men, and enterprises further qualify him for a significant role in meeting environmental objectives by interdisciplinary means.

To effect such coordination will require improved lines of communication, understanding, knowledge, and empathy between the engineering and social sciences in working toward common objectives. In this regard, the engineering society, our universities and colleges, and industrial and governmental training programs will each have an important role to play.

Since a great many of our pollution problems may require regional handling, the environmental engineer and his fellow professionals can prove helpful to governing bodies in establishing the need for new and broader types of political and jurisdictional machinery to deal with their solution. In these and in other ways, environmental engineering may combine the skills and training of the engineer with those of the sociologist, economist, and others in an intraprofessional manner yielding long-range social benefits.

The complexity of environmental problems requires more extensive training for the young engineer along with the reeducation of those now in practice. While the role of the engineering education institution is itself complex, a broadening of traditional curricula to include courses in the social and behavioral sciences would seem highly desirable. Engineering schools should be encouraged to design their programs to permit maximum opportunity for the student to interact with other professional disciplines.

Corporate and governmental on-the-job training programs, meanwhile, should actively stress the development of an environmental control philosophy, backed by the managerial commitment necessary to its implementation. As newly oriented engineers develop greater expertise in environmental pollution control, they will become the nucleus for a constant regeneration of these important principles. The enriching infusion of young engineers into the profession is of prime importance not only for the new techniques and viewpoints which they bring to bear on existing problems, but because they represent the feelings, ideas, and sense of values of the younger generation. Every effort must be made, therefore, to continue to encourage and cultivate young engineers and provide them with the opportunity to broaden their training, particularly in environmental and interdisciplinary areas.

Currently, however, we are faced with a shortage of adequately trained environmental engineers. Engineering is but one of many professions which bear a responsibility toward environmental betterment and the fulfillment of society's most cherished goals. The physicist, chemist, architect, sociologist (to mention but a few) have an equally important role to play. Realistically speaking, however, even the combined skills and knowledge of these dedicated workers require the support and involvement of the people as a whole if we are to attain our goals on anything resembling a meaningful or lasting scale.

What is required, therefore, is no ordinary undertaking. Rather, there must develop the pursuit of excellence in every endeavor in which we engage--both as a nation and as individuals. Technology is capable of solving only certain of our problems. It can help to decongest urban areas, reconstruct deteriorating neighborhoods, provide for improved communications and transportation systems, and so on. But it cannot provide the will to bring such changes into being nor the determination to pay the costs required. This will and this determination must come from society as a whole.

And in this context, the engineer, for his part--fortified by the conscience of his profession and by the skills and training requisite to an improved technology and to its "better use"--will contribute much of value and benefit to his fellowman.

ENVIRONMENTAL STUDIES UNIT EXAMINATION

I. Essay Questions. (Answer two of the following essay questions assigned by your teacher--20 points each.)

1. "The major reasons for the problems of pollution today are unbridled technology and overpopulation." Defend, attack, or modify this hypothesis. Be sure to support your answer with facts and data.

2. "The pollution problems in the United States are so large and complicated that the average individual cannot do anything by himself to stop or prevent them." Defend, attack, or modify this hypothesis, using facts to support your answer. Be sure to reach a clear conclusion in your answer.

3. List seven major pollution problems in the United States and explain: (1) why they are problems; (2) why they occur; and (3) what needs to be done to correct and prevent them. (Explain means that the reader knows nothing about the subject and you are telling him all about it.)

4. What is man's relation to the environment? Support your answer with facts and data.

II. Define five of the following terms (2 points each).

(a) ecology
(b) ecosystem
(c) ecotactics
(d) environment
(e) pollution
(f) recycle
(g) natural resources
(h) conservation
(i) environmental manpower needs
(j) environmental-ecological education

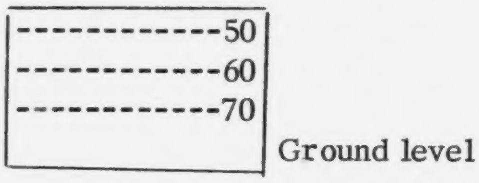
III. Multiple-Choice Questions. Circle the letter before the best answer. Some questions have two correct answers (1 point each).

1. The major contributor to the pollution of the air is:
(a) industrial plants (b) garbage dumps (c) motor vehicles (d) power plants (e) all of the above.

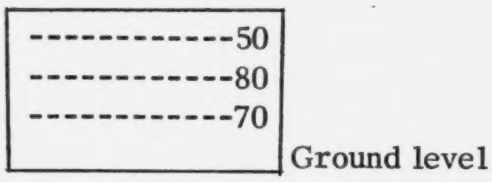
2. Which of the following statements most accurately describe the Earth's water? (a) There is plenty of usable water for man in the lakes, streams, rivers, and oceans. (b) The Earth's supply of water is decreasing. (c) The Earth's supply of water is increasing. (d) The Earth's supply of water has remained relatively constant for millions of years. (e) None of the above.

3. Which of the following illustrations is a correct sample of a temperature inversion?

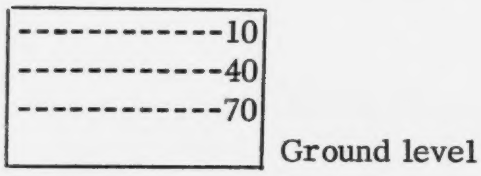
(a)



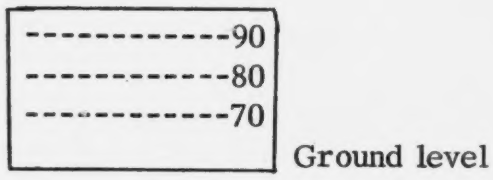
(b)



(c)



(d)



(e) a and d above.

4. The water in the average man (a) makes up over 60% of his body. (b) is less than 50% of his body. (c) remains constant throughout his life. (d) is not as important as food and oxygen. (e) b and c above.

5. Water pollution is a problem (a) only in the United States. (b) only in the Western world. (c) in all inland lakes, streams, and rivers of the world. (d) spreading throughout the entire world. (e) none of the above.

6. Which of the following is the best description of the Earth's water cycle? (a) The majority of the Earth's water is trapped in underground tables. (b) Over 80% of all water evaporation occurs over the oceans. (c) Rainwater is becoming increasingly polluted. (d) Over 1% of the total supply of water is always in the water cycle. (e) b and d above.

7. Which of the following occupations does NOT deal directly with reducing and stopping water pollution? (a) Power plant engineer (b) Automobile mechanic (c) Industrial waste inspector (d) Aquatic biologist.

8. The best way to reduce air pollution in the cities would be to (a) replace the internal combustion engine with some other type of power. (b) eliminate all leaded gasolines. (c) pass stricter laws that regulate power plants. (d) prohibit citizens to have open fires in their yards. (e) all of the above.

9. Air pollution resulting from colorless and poisonous gases in the air not only threatens the health of human beings who inhale it but also does all of the following EXCEPT (a) kills and damages vegetation. (b) causes temperature inversions that produce dense smog. (c) destroys and defaces public and private

buildings. (d) may cause significant modifications in the world's weather.

10. The occupation concerned most with air pollution would be the (a) sanitation men. (b) aquatic biologist. (c) combustion engineer. (d) civil engineer.

11. The average citizen throws away approximately (a) less than a pound of waste per day. (b) three-and-a-half pounds of waste per week. (c) over five pounds of waste per day. (d) three-and-a-half pounds of waste per day.

12. "A fundamental reason for concern about this problem is the threat that it imposes on the health and well-being of the public and the role it may play in the spread of communicable diseases. The most prominent health factor associated with this problem is domestic flies which are carriers of many disease agents. While control of communicable disease is of paramount importance, it is more meaningful in discussing this problem to take a broad view of the term 'public health.' No longer can we restrict attention only to the factors involved in the spread of communicable diseases. Of equal importance is the broad and pressing public interest in all factors of environmental health including the aspects of comfort, enjoyment of life, and the general physical and mental well-being of the public. On the basis of this broader outlook, there are many points of public health concern which relate to the manner by which this problem adversely affects our land, air, and water. In addition to the direct effect of this problem on the quality of these three elements, are the accompanying physiological or psychological effects on man. These may range from immediate danger, such as physical harm, to merely a less pleasant or less comfortable environment, such as that which offends the five senses."

    The aforementioned quotation describes the problems closely associated with (a) air pollution. (b) water pollution. (c) solid wastes. (d) depletion of natural resources. (e) a, b, and c above.

13. Which of the following is a step in the recycling process? (a) Buying milk in cardboard cartons. (b) Buying soft drinks in nonreturnable bottles. (c) Buying milk in glass bottles. (d) Buying soft drinks in plastic containers.

14. Modern man's attitude toward nature differs from the other animals in nature in what way? (a) He has developed a balance with his food supply and can maintain that balance indefinitely. (b) He uses up the resources necessary for survival rather than working to preserve them. (c) The essentials of life consist

of keeping warm. (d) He lives and works in nature as part of the ecosystem rather than an entity separate from nature.

15. An endangered species is one
(a) whose existence is threatened by man's destruction of nature. (b) whose existence depends upon man's providing for it. (c) that has become extinct. (d) all the above.

16. Sanitary engineers are concerned with
(a) the water we drink and use and the air we breathe. (b) the food we eat, the homes we live in, and the buildings we work and learn in. (c) the vehicles we travel in and the places we visit for recreation. (d) all the above.

17. The best definition of noise is
(a) loud sounds (b) unwanted sounds (c) too many sounds (d) excessive sounds.

18. While we indulge in worthy, earnest, but nevertheless limited enterprises, such as saving whooping cranes, we fail to notice our own growing eligibility for the title "endangered species." What is directly endangering man's existence as a species in the future?
(a) Unbridled technology (b) Race (c) Overpopulation (d) Economic inequities.

19. Which of the following can you start doing immediately that will have a direct effect upon the environment?
(a) Write a letter to your Senator protesting the lack of legislation to protect the environment. (b) Refuse to throw papers, cans, cigarette butts, etc., anywhere but in properly designated receptacles. (c) Walk, ride a bicycle, use mass transit systems or form car pools to help reduce the number of cars on the road. (d) Request that your school provide ecological/environmental education for all interested students.

20. What occupations and professions are concerned with problems of the environment?
(a) Engineers. (b) Educators. (c) Students. (d) All of above.

IV. Environmental Awareness. (Answer all five questions--30 to 80 points.)

1. Rank the problems listed below according to what you consider to be the most serious short-range and long-range threats to mankind.

	Short-range	Long-range
(1) Communism		
(2) Crime		
(3) Drugs		

Short-range Long-range

(4) Economic inequities
(5) Overpopulation
(6) Pollution
(7) Racism
(8) Uncontrolled technology
(9) War
(Explain the reasons for your ranking.)

2. Below are ten problems of the environment listed in alphabetical order. Rank each one from the most serious (represented by 1) to the least serious (represented by 10). Then state the reasons for the way you ranked the problems. You will be graded on the following criteria: (a) accuracy of factual information to support your choices; (b) clarity of expression in explaining your choices; (c) relevance; (d) ability to think critically; (e) originality.

Air pollution
Depletion of metals, minerals, and fuels
Endangered species
Man's altering and changing the landscape
Mercury and other metal pollutants
Noise pollution
Overpopulation
Pesticides
Solid wastes

Most serious
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
Least serious

3. Rank the groups below in the order of those that are most responsible for stopping, controlling, and preventing pollution and destruction of the environment. State reasons for your choice.

Educational institutions
Federal government
Individual citizen actions
Local county, city, and metropolitan governments
Private citizen groups and organizations
Private industry and business
Regional governmental institutions
State governments
United Nations
Others (write in your own group)

Most important
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
Least important

4. Which of the following statements expresses your attitude toward the problems of pollution? Explain the reasons for your answer. (a) Pollution of the air and water by industries and cities must be stopped, even at the expense of a loss of jobs and an increase in prices and taxes. (b) Pollution of air and water must be controlled, and industry is the major contributor to these problems. (c) Pollution of air and water must be prevented by the government passing and enforcing tougher pollution laws and appropriating taxes to pay the costs. (d) Pollution of air and water can best be controlled by government and industry working together on a voluntary and noncoersive basis. (e) Pollution of air and water needs to be stopped, but not if it means a loss of jobs and increased taxes.

5. What type of a program do you think is needed in the schools to better educate the students to better understand and care for the environment that surrounds us? (Be specific and precise in your answer.)

II. ENVIRONMENTAL STUDIES: A SEMESTER COURSE

This course was designed to be inserted into high school curricula both as a complementary course in life and social sciences and as an additional course covering the special interdisciplinary nature of ecology. The outline and daily subject guide were designed so that they can be used with a variety of materials, not just the ones designated herein.

The objective of this course will be to comprehensively examine the major processes of life that, considered together, form the natural environment of planet Earth, and the major human endeavors which have profoundly affected the natural systems. Methods involved include reading, classroom discussion, outdoor activities, film viewing, and special projects. The course provides students with an understanding of the major physical forces and natural resources of the Earth, an understanding of the interrelationships of all life, an understanding of the major causes of environmental deterioration, and a consideration of solutions to environmental problems, with special emphasis upon career opportunities in the environmental area. The goal is a realization of the unity of man and nature, and a consciousness of the necessity for an ecologically responsible manner of living.

This course can be taught in a variety of ways. A single instructor with a background in natural sciences, or social sciences, or literature (preferably with at least an interest in all three areas) could teach the course. Career information material should be developed in consultation with a vocational counselor. None of the material to be covered, the concepts involved, or the problems to be solved is difficult to understand or teach; each secondary school should have on its faculty an instructor capable of teaching the class. Another method is the team-teaching technique, with a specialist from each area responsible for the presentation of the material to be covered in his particular specialty. If this technique is employed, the instructors could be used solely when their specialty is needed and then turn the teaching over to another team member; or both or all three of the specialists could be present for all the classroom sessions. This approach would allow for helpful and healthy interchanges and debates over theories and concepts and would allow the students greater voice and stimulation rather than just absorbing unchallenged expertise.

On the daily schedule, suggestions are given for discussion subjects only for the major points of any one topic. Each instructor adopting this outline or adapting another from it is reminded that this outline and the daily guides are merely that. Individual lesson plans must be developed by the instructor teaching the course. It may be helpful in some cases to invite guest speakers to lend specialized knowledge in particular subject areas (i.e., natural resource managers, public health officials, demographers, etc.).

The schedule is flexible and can be arranged differently: In many cases, the material suggested for one day is sufficient for several days' discussion. The instructors are reminded to carry these discussions to profitable conclusions before proceeding to another topic. Alterations, additions, and deletions are possible to whatever extent desirable by the instructor. By spending more time on each subject, this outline could easily be adapted to cover a full year's course. To handle anticipated delays, scheduling problems, or financial and transportation difficulties, alternative daily topics can be given whenever a field trip or film is planned. Each time a film is scheduled to be shown, the teacher should first preview its contents, then briefly before and after the showing, discuss the film with the class and explain how this particular film related to the particular subject and the overall content of the course. When a film is unavailable, the instructors should either use the alternative plans or continue the discussions of material not previously covered. The films selected for this course represent those which generally cover a particular subject, and substitutions can be made.

The textbooks chosen for this course vary considerably, as do the anthologies and literary works. Only one selection from each should be given to or purchased by each student to be his source material. For each day's subject guide, the page numbers of the sources cited are listed as assignments for the students. In some cases, none of these sources fully covers the material from a teaching viewpoint, and some additional references may be needed by the teacher or teaching team. Other texts not selected should be purchased and used as supplementary material by the teacher and students. For a complete listing of environmental source material, consult the bibliography in chapter 4. Each school planning to adopt this or any other environmental education program into its curriculum is reminded to purchase several additional pieces of information for faculty and student use in the classroom and in the library.

Recommended Texts for Environmental Studies:

(Choose one text from each of the following categories.)

A. Textbooks

Dasmann, Raymond. 1968. Environmental Conservation, 2d ed. New York: John Wiley. $4.95*.

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*Retail prices.

Ehrlich, Paul R., and Anne H. Ehrlich. 1970. Population Resources Environment. San Francisco: W. H. Freeman. $8.95.

Wagner, Richard H. 1971. Environment and Man. New York: W. W. Norton. $7.50.

B. Anthologies

DeBell, Garrett (ed.). 1970. The Environmental Handbook. New York: Ballantine. $0.95.

Shepard, Paul, and Daniel McKinley (eds.). 1969. The Subversive Science: Essays Toward an Ecology of Man. Boston: Houghton-Mifflin. $5.95.

C. Literary views

Commoner, Barry. 1971. The Closing Circle. New York: Knopf. $6.95

Leopold, Aldo. 1966. A Sand County Almanac. New York: Oxford. $0.95.

Muir, John. 1961. The Mountains of California. New York: Natural History Library. $1.45.

Thoreau, Henry D. 1960. Walden. New York: Signet. $0.95.

Examples of Term Projects for Environmental Studies

One topic should be chosen by the entire class and must be completed by the class acting jointly. One topic should be assigned to an individual or a team acting independently. Assign the term projects by the second or third week of the course.

1. Conduct after-school of weekend litter pick-up campaigns.

2. Conduct a program to plant needed shrubs, lawns, or trees on the school's campus or on state or municipal property.

3. Establish a recycling center.

4. Conduct evaluation studies on local pollution control systems, i.e., waste water treatment plants, dumps or sanitary land fills, air purification and filtration systems for industry, etc.

5. Organize and conduct a series of environmental education programs for younger students in elementary schools, with the students being the teachers.

6. Grow a garden organically.

7. Conduct a small, manageable study of a local, somewhat self-contained, biotic community or ecosystem.

8. Conduct evaluation studies of local or regional natural resource distribution, development, and use; i.e., fresh water systems, land development, agriculture, electrical production and deployment, mineral and fuel extraction and use, etc.

9. Make an academic research paper study of any of the topics or subtopics listed in the curriculum outline.

Environmental Studies: Course Outline

I. Environmental Systems

- A. Ecology
    1. Biotic communities and ecosystems
    2. Food chains
    3. Natural cycles--nitrogen, carbon, phosphorus, oxygen, etc.
- B. Evolution
    1. Animal behavior, territoriality, etc.
    2. Natural selection
    3. Human revolution

II. Natural Resources

- A. Water
    1. Hydrological cycle (rainfall patterns)
    2. Worldwide distribution of water
    3. Plant, animal, and human use
    4. Storage, transportation, recycling, converting
    5. Pollution
        - a. Types--sewage, industrial, agricultural
        - b. Forms--biotic, chemical, mineral, thermal, pesticides, others
        - c. Health hazards
    6. Eutrophication
    7. Solutions to abuse and overconsumption
- B. Land
    1. Soils--formation, type, structure
    2. Types, by growth and climate
        - a. Forests--boreal, temperate, tropical
        - b. Grasslands
        - c. Deserts
        - d. Arctic
    3. Use--agriculture, forests, social, wilderness
    4. Abuse--solid wastes (surface mining, etc.), social mismanagement
    5. Preservation--land ethics, wilderness and national parks, zoning and restrictions on use.

C. Wild species

1. Population and niches
2. Distribution and types
3. Use--exploitation, management, husbandry
4. Abuse--extinction
5. Preservation

D. Fuels, minerals, and energy

1. Types and distribution
2. Production and use of metals and fuels
3. Depletion and pollution--radiation, spills, slag, overproduction, and overconsumption
4. Electrical power
    a. Consumption
    b. Hydrological and steam-generating
    c. Atomic and fossil fuels

E. Air

1. Composition and cycle of atmosphere
2. Weather
3. Pollution
    a. Types--chemical, biological, etc.
    b. Causes--industry, automobiles, power production, etc.
    c. Hazards to health
4. Solutions to abuse

III. People and Society

A. Population

1. Reproduction
2. Distribution and structure
3. Growth and projections
4. Management methods

B. Food resources

1. Agriculture--crops, animal husbandry, etc.
2. Production methods--irrigation, machinery, fertilizer, chemical pesticides, hybrids, improved seeds, etc.
3. Future outlook

- C. Shelter
    - 1. Architectural styles
    - 2. Urbanization
- D. Modern social problems
    - 1. Transportation
    - 2. Crowding and noise
    - 3. Aesthetics
    - 4. Health

IV. Cultural Perspectives

- A. Literary
    - 1. Personal
    - 2. Ethical
    - 3. Philosophical
- B. Historical
    - 1. Frontier development
    - 2. Industrialization
    - 3. Modern society
- C. Future
    - 1. Predictions
    - 2. Courses of action
- D. Laws
    - 1. Regulations, statutes, codes, etc.
    - 2. Enforcement

V. Natural Area Study

- A. Field trips
- B. Special projects
- C. Wilderness and survival training

ENVIRONMENTAL STUDIES
Daily subject guide, with presentation suggestions and sources

Week #1 ENVIRONMENTAL SYSTEMS

1. Class Introduction

Distribute textbooks, materials, syllabus, and check registration, etc. Preview class content, methods, assignments, and objectives--particularly the term project.

2. Concept of Ecology

Discuss with the class the meaning of "ecology" as derived from assigned readings and past experiences. Find out the levels of acceptance of the idea, the need for "ecological awareness," etc. It may be helpful to give an "environmental awareness quiz" to determine depth and breadth of the students' knowledge.

SOURCES: Dasmann, 1-6; DeBell, 1-11; Shepard, 1-10; appendix 3-2 from this handbook.

3. Biotic Communities and Food Chains

Discuss with the class the interrelationships of the subjects (it may be helpful to compare the "natural" communities and chains with "social" ones which exist in the students' neighborhoods). Give examples of local food chains and biotic communities. Include a discussion on the biological need for all life forms within a system.

SOURCES: Dasmann, 9-12; Ehrlich, 157-59; Wagner, 230-36.

4. Basic Life Cycles

Discuss with the class the cycles of carbon, nitrogen, oxygen, phosphorus, and the concepts of birth, growth, maturity, decline, and death. Cover also succession, erosion, and the fundamental idea that we are living on a spaceship with a "closed system" (except for solar energy transfer). Compare natural cycles to the life cycle of man.

SOURCES: Dasmann, 13-24; Ehrlich, 161-67; Wagner, 50-59.

5. Film

"Basic Ecology" or "Ecology Communities." (As an alternative, lead a roundtable discussion comparing different students' views of nature, society, and ecology.)

Week #2 ENVIRONMENTAL SYSTEMS

1. Outdoor Activity

Divide the class into manageable groups and have them conduct an environmental study of the school campus, with particular regard given to the separate biotic communities and food chains evident in the local plants and animals. Have the class report their findings at the end of the hour. (As an alternative, catalog the school's library holdings of nature-related books and put them on reserve--then take the class to the library and let them browse around and select textbooks for written reports to be made at a later date.)

2. Evolution--Natural Selection

Discuss with the class the physiology of animals and plants. Point out the various functions of the component parts, particularly those relating to survival. Discuss the time span necessary for geologic and biological changes (evolutionary or devolutionary) and the causes of these changes. Discuss animal behavior, territoriality, and natural selection as they pertain to food gathering, mobility, camouflage, reproduction, etc. Compare the natural concept of evolution with the evolution of the school, neighborhood, or city.

SOURCES: Ehrlich, 11; Wagner, 5-11; any biology or geology textbook; Dasmann, 55-61.

3. Human Revolution

Point out how man's particular evolution led to his dominance. Detail man's physical development (opposable thumb, bipedal locomotion, stereoscopic vision, large cranial capacity), the development of culture, the development of agriculture and cities, and the development of industry as the most significant developmental steps. Trace his prehistoric ancestors and compare their physical and environmental similarities and differences.

SOURCES: Ehrlich, 202-04; Shepard, 13-41; Wagner, 11-20; any biology or anthropology textbook; Dasmann, 55-84.

4. Film

"House of Man--Our Changing Environment." (As an alternative, participate in a review session with the students, outlining major concepts covered and the problems solved.)

5. Examination

This should cover the material discussed under ENVIRONMENTAL SYSTEMS above.

Week #3 NATURAL RESOURCES

1. Water, the Hydrological Cycle

Discuss the assigned reading in class, pointing out chemical differences between fresh and salt water and the patterns of rainfall of the world. Discuss the necessity of all living things for water. Point out its renewability, different forms, condensation, evaporation, etc.

SOURCES: Dasmann, 141-48 ; Ehrlich, 63-65; Wagner, 93-98.

2. Water, Distribution and Use

Lecture on the multiple-storage facilities (oceans, lakes, rivers, estuaries, groundwater, clouds, etc.) and multiple use (agriculture, industry, animal and plant consumption, etc.). Discuss the storage, transportation, recycling, and converting powers of man. Have the students explain all their uses of water.

SOURCES: Handout (Day 3) from the 15-day unit; Dasmann, 148-170; Wagner, 98-105.

3. Water, Pollution

Ask the students to identify the major types of water pollution (biotic, chemical, mineral, thermal, etc.) and the major causes of pollution (sewage, agriculture, industry, etc.). Develop plans to individually reduce water pollution. Analyze samples of polluted water under a microscope. Discuss present waste-water treatment plant types (primary, secondary, and tertiary) and the use of desalination operations.

SOURCES: Dasmann, 152-55 ; DeBell, 51-65; Ehrlich, 126-28, 185-89; Wagner, 107-26, 137-42.

4. Eutrophication

Discuss the concept of living and dying bodies of water (oligotrophic and eutrophic); relate it particularly to the food chain concept. Catalog water supplies and storage facilities in your city or state and classify according to amount of "life." Analyze the local and worldwide use of lakes, rivers, estuaries, and oceans as dumping grounds for unwanted waste materials.

SOURCES: Ehrlich, 185-89; Wagner, 127-31, 150-61.

5. Film

"The Living Sea." (As an alternative, microscopically analyze more samples of water collected at various points in your area.)

Week #4 NATURAL RESOURCES

1. Land, Geology and Soils

Discuss the major rock types, formation, stratification, land classification (mountains, valleys, plains, etc.), volcanization, glaciation, continental uplift, drift, and weathering, faults, etc. Discuss also soil formation, aeration, fertility, classification. Analyze soil types (humus base, clay base, sand base) under a microscope.

SOURCES: Dasmann, 99-119; Wagner, 38-54; any geology textbook.

2. Land, Types

Discuss the major land/climate types (arctic, temperate, tropical) and the major land cover (tundra, forest--coniferous, deciduous, alpine, tropical--grassland, and desert). Compare the types and distributions with weather, soil, and population.

Many films are available on this subject, including short ones (15 to 20 minutes) on "The High Arctic Biome," "The Temperate Deciduous Forest," "The Grasslands," "The Desert," and "The Tropical Rain Forest."

SOURCE: Dasmann, 27-53.

3. Land, Human Use

Compare natural land cover with human use, with respect to agriculture, mining, cities, transportation, parks, etc. Use classroom maps to point out the worldwide development and use of land. Get a map of your own local area and classify it according to the use of land (in terms of both area and percent) with regard to streets, housing, commerce, industry, gardens and parks, waterways, undeveloped and wilderness areas, etc. (Use translucent paper to outline land use and indicate environmental problems.)

SOURCES: Ehrlich, 91-92; Wagner, 25-29; local city or county map--land use information can be obtained from your tax assessor; Dasmann, 119-131, 289-94.

4. Land, Human Use

Discuss man's use of his forest reserves, particularly with regard to his modifying the natural ecosystems and cycles. Survey the class to identify the belief/nonbelief in the "Smokey-the-bear philosophy" of fire management. Discuss the ecological differences between forest and rangelands. Discuss the multiple historical and contemporary uses of timber and wood products.

SOURCES: Dasmann, 173-228; Wagner, 79-92.

5. Land, Abuse and Preservation

Discuss man's abuse of the land through resource depletion and solid waste disposal. Classify the kinds of solid waste (metals, glass, paper, sewage, etc.), noting biodegradability of different types. Discuss methods to eliminate waste (land fills, recycling, reduction of consumption, discretionary purchasing, etc.). Find out how your community disposes of its wastes.

SOURCES: DeBell, 214-18; Ehrlich, 128-29; Wagner, 409-24; readings from 15-day unit (Days 2 and 7); Dasmann, 305-06.

Week #5 NATURAL RESOURCES

1. Land, Ethics

Discuss the philosophical concepts apparent in the readings, particularly those relating to the nonhuman use of land in wilderness areas and the human use in park areas. Locate the national parks on a map and compare in size to the other land areas of the United States. Make a list of all the parks and natural areas in your community and immediate environs. Compare the concept of land ownership (legal and private property and public trusteeship) with animal territoriality. Discuss the idea of "marrying the Earth."

SOURCES: DeBell, 147-52; Shepard, 402-15; Wagner, 60-75; Appendix 3-1 from this handbook ; Dasmann, 87-97, 273-87.

2. Film

"America's Wonderland, the National Parks." (As an alternative, have the students work on their term projects, which should have been assigned or chosen by the second or third week.)

3. Wildlife, Species and Habitat

Have the class list all major wildlife species in North America (fish, fowl, animal). Find out where selected types live, in what biotic community, and in what food chain. Catalog all major wildlife living in your immediate geographical area. Analyze the life styles of some of the major types (i.e., deer, trout, duck, beaver, etc.). Discuss the ecological necessity of herbivores, omnivores, and carnivores; in particular, man's view of predators. Compare the life styles of man and beavers as species which radically change and improve their environments.

SOURCES: Dasmann, 231-53 ; Shepard, 179-90.

4. Film

"Problems of Conservation: Wildlife" or "Man, Beast, and the Land."

5. Wildlife, Use

Discuss the exploitation, management, and husbandry of wildlife forms, including sport hunting and fishing. Compare wildlife (including herbivores and carnivores) with domesticated animals. Examine the worldwide use of wildlife as sources of food. Analyze the phenomena of hunting and fishing in industrial societies, particularly the term "sportsman."

SOURCES: Dasmann, 253-71; DeBell, 92-95; Ehrlich, 101-09.

Week #6 NATURAL RESOURCES

1. Wildlife, Extinction

Discuss the methods and causes of extinction throughout world history (assault, inability to adapt, habitat destruction, etc.). Discuss the biological need for variation in life forms. Examine the environmental threats to mankind which may lead to his extinction. Compare the extinction pattern of two different species (dinosaurs, passenger pigeons, original North American horse, sea mammals, etc.).

SOURCES: Ehrlich, 165-80; Wagner, 225-42, 300-23; readings (Days 10 and 13) from the 15-day unit; Dasmann, 236-48.

2. Field Trip

Visit a local zoo, sea aquarium, domestic or game animal ranch, or natural history museum. (As an alternative, develop case studies on selected extinct or near-extinct species [i.e., whales, bison, eagles, pigeons], and list the means of preservation for endangered wildlife.)

3. Film

"Our Endangered Wildlife." (As an alternative, have the students complete the reading assignments or work on their term projects.)

4. Fuels and Minerals

Discuss the types and distribution of metals (precious, ferrous, nonferrous) and fuels (fossil, atomic, forest, peat). Calculate the known reserves for the United States and the world.

SOURCES: DeBell, 66-75; Ehrlich, 51-63.

5. Production and Use--Fuels, Minerals, and Energy

Discuss the principal uses of metals (production of goods), fuels (supplying heat, providing lubrication, supplying power for transportation), and energy (i.e., hydroelectric power for electricity), and the corresponding methods of production (drilling, mining, damming, etc.). Analyze the world's dependency on metals and fuels, noting in particular use in the U.S. and industrialized countries. Consider the use of alternative fuels or sources.

SOURCES: Dasmann, 309-13; Ehrlich, 51-63; Shepard, 312-15; Wagner, 133-37, 148-48.

Week #7 NATURAL RESOURCES

1. Depletion of Resources and Pollution

Discuss the use and the supply rates and relate both to economic concepts of principle and interest. Discuss human life styles as indicative of resource depletion. Discuss major pollution forms and their causes (oil spills, abandoned mines and quarries, strip mines, slag heaps, radiation, toxic minerals, silting of reservoirs). Develop plans to slow resource depletion and pollution.

SOURCES: Wagner, 162-69, 196-219, 246-59; reading (Day 9) of 15-day unit.

2. Classroom Investigation

Identify, chart to the original source, and study all sources of heat, electricity, gas, and water which enter the classroom, including conservation steps. Discuss with the students the possibility that sources of power, fuels, minerals, etc. might someday be interrupted on a temporary or permanent basis. Analyze the alternatives suggested.

3. Classroom Investigation

Identify, classify, and trace back to the raw material all construction components of the classroom (desks, walls, blackboards, windows, fixtures, etc.). Group according to natural (born) and artificial (made) materials; discuss differences.

4. Air, Atmosphere

Discuss the composition, formation, and cycle of the atmosphere, relating them to the life cycles discussed in Week 4 of this course. Discuss the interdependence of all life forms with the atmosphere. Discuss the concept of photosynthesis. Find the major sources of the main atmospheric elements--nitrogen, oxygen, carbon dioxide.

SOURCES: Ehrlich, 165; Wagner, 54-55; any biology text.

5. Air, Weather

Discuss the weather and weather patterns and their effects on soils, agriculture, population, etc. Compare the "albedo" and "greenhouse" effects. Examine in detail the annual weather patterns in your community.

SOURCES: Ehrlich, 145-48; Wagner, 104-05.

Week #8 NATURAL RESOURCES

1. Air, Pollution

Discuss the various types of air pollution (photochemical smog, fog, pollen, etc.), the various sources (automobiles, power generation, industry, heating, refuse), and the effects on human health, plant life, and man-made materials. Chart the appearance of the various contaminants in the air. Develop plans to reduce air pollution in your community.

SOURCES: DeBell, 113-26; Ehrlich, 118-26; Wagner, 171-92; adapted text from Day 5 of the 15-day unit; Dasmann, 305-09.

2. Film

"The Poisoned Air." (As an alternative, conduct experiments and tests of the air with kits detailed in the bibliography.)

3. Field Trip

Visit a local pollution control facility (i.e., water treatment plant, sanitary land fill, electric generating plant) and observe its facility and method in abating pollution. (As an alternative, allow the students extra reading and review time.)

4. Film

"Pollution Is a Matter of Choice." (As an alternative, allow time to work on term projects.)

5. Classroom Project

Divide the class into groups and develop an "Environmental Bill of Rights" for personal and community use concerning our waters, lands, wild animals, air, minerals, fuels, etc. Consult the list developed on Day 14 of the 15-day unit and the plans developed on Days 13, 18, 20, 26, 31, and 36 of this course. Start action groups among the students to press for better municipal controls, tighter state laws, and better personal and industrial cooperation in pollution control.

Week #9 NATURAL RESOURCES

1. Review Session

Review and answer questions relating to factual information and problem-solving techniques for the material just completed.

2. Examination

This should cover the material discussed under NATURAL RESOURCES.

3. Assigned Project Work Day*

Give the students time to develop methods, conduct research, or perform any tasks relating to their special term projects.

4. Assigned Project Work Day

5. Assigned Project Work Day

Week #10 PEOPLE AND SOCIETY

1. Population, Reproduction

Discuss with the students the mechanisms involved with human reproduction, with emphasis given to the reproductive process as a means to continue the species. (As an alternative to this topic, discuss the concept of reproduction considering all life forms, animal and plant.)

SOURCES: Ehrlich, 356-59; any physiology or biology textbook.

2. Population, Structure

Discuss the distribution, density, age, sex, education, and wealth of the world's population. Compare data on developed countries (mostly industrial) and undeveloped countries (mostly subsistence agriculture).

SOURCES: Dasmann, 315-18 ; Ehrlich, 25-50, 329-40; Shepard, 42-54.

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*In lieu of the assigned project work days, this time could be spent discussing any material heretofore not covered.

3. Population, Growth

Discuss the increases of the world's human population with regard to birth and death rates, fertility rates, etc., and cultural phenomena (rise of agriculture, wars, plagues, economics, etc.). Use some handy device (i.e., matches, toothpicks, marbles) to demonstrate the growth-rate concept. Compare the rate differences between selected industrial and agricultural countries. Make predictions on the future size of the world's population based upon different rates. Compare population size and growth with environmental deterioration.

SOURCES: Dasmann, 318-25; DeBell, 219-32; Ehrlich, 5-24, 199-210; Wagner, 429-33.

4. Population, Management

Discuss the various methods and procedures now in use or planned to manage the growth of the world's population, including population redistribution, methods used to prevent birth and increased production of foodstuffs and resources.

SOURCES: Dasmann, 325-29; Ehrlich, 211-32; Wagner, 451-61; alternative reading (Day 11) from the 15-day unit.

5. Population, Planning

Discuss the economic, religious, racial, and national differences regarding planned human birth. Compare human population growth (and the corresponding consumption of food and natural resources) with animal population balance, particularly with regard to living in a harmonized ecosystem.

SOURCES: Dasmann, 236-48; Ehrlich, 233-58; Shepard, 99-111.

Week #11 PEOPLE AND SOCIETY

1. Film

"The Population Explosion." (As an alternative, have the students conduct an in-class survey of the sizes of their existing families, the sizes of their future families, and the environmental cost of each added birth to their community.)

2. Food, Production

Discuss the varieties of agriculture, fish and game harvesting, and animal husbandry in the world. Discuss the difference between "natural" and "prepared" foods, perhaps by analyzing the class's diet and cataloging what they eat. Discuss concepts of protein, calories, etc.

SOURCES: Dasmann, 130-35; Ehrlich, 81-88; Shepard, 55-75.

3. Food, Resources

Discuss the dietetic possibilities available to the world, considering crops consumed, animals eaten, acres under development, cost of production, soil preparation, etc.

SOURCES: Wagner, 433-40 ; Ehrlich, 88-109; Shepard, 190-209; Dasmann, 109-19, 131-35, 320.

4. Future Food Sources

Discuss the development of novel sources of food, including game ranching, sea harvesting (for products other than fish), crop substitution, increased land cultivation, conversion of existing products, and direct synthesis.

SOURCES: DeBell, 29-95; Ehrlich, 109-13; Wagner, 440-49.

5. Food, Biocides and Additives

Discuss the use of pesticides, fungicides, and herbicides to improve crop yield (relate to their other environmental implications) and the use of additives and contaminants to processed food to improve color, taste, preservation, etc.

SOURCES: DeBell, 76-91; Ehrlich, 165-85; Shepard, 245-65; Wagner, 225-45, 261-74; Dasmann, 135-38.

Week #12 PEOPLE AND SOCIETY*

1. Film

"The Food Revolution." (As an alternative, allow the class additional reading time.)

2. Classroom Project

Have the students prepare (either at home or at school) and consume (at school) a "natural meal." Make sure everyone knows the ingredients and the recipes, not allowing any prepared products such as pizza pie, jello, frozen waffles, etc. If possible, consume whatever food is grown by students for their term projects.

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*See Week #15 for book to be assigned.

3. Shelter--House Forms

Discuss variations in worldwide living accommodations due to external environments and internal desires. Compare the worldwide structural similarities, building materials, settings, etc.

SOURCES: Shepard, 158-68, 168-76, 328-32; Wagner, 343-59; any architecture textbook.

4. Urbanization

Discuss the ideas relating to the location and formation of cities, their relationship (economic and cultural) with the surrounding rural areas, the growth of industrialization and commerce, and the influx of people into cities or their suburbs. Compare city development in North America, Europe, and Asia.

SOURCES: Ehrlich, 37-41; Shepard, 369-83; Wagner, 360-82; any U.S. history textbook.

5. Urban Problems

Discuss the conditions which lead to urban decay, slums, increases in crime, mental and physical illness, overloaded waste disposal systems, human hostility, etc.

SOURCES: DeBell, 234-52; Ehrlich, 141-43; any sociology or U.S. history textbook; Dasmann, 299-305.

Week #13 PEOPLE AND SOCIETY

1. Film

"Challenge for Urban Renewal." (As an alternative, have the students investigate the ways in which their community is attempting to solve its related social and environmental problems.)

2. Transportation

Study the methods of transportation (walking, bicycling, automobiles, trains, airplanes, ships, etc.) and the history of the development of systems designed to accommodate them (roads, canals, highways, railroads, etc.). Suggest methods designed to cure the transportation problems.

Examine your community's transportation systems.

SOURCES: DeBell, 177-81, 182-96, 197-213; Wagner, 384-408.

3. Aesthetics

Discuss concepts of natural beauty and created (man-made) beauty. Discuss the need for beauty by man, particularly the need for natural life (flowers, plants, etc.) in artificial environments (living rooms, offices, etc.). Identify objects (in and out of the classroom) the students believe are examples of beauty. Compare beauty with form and function.

SOURCES: Ehrlich, 143-45; Shepard, 115-21; most art and architecture textbooks; Dasmann, 278-80.

4. Crowding--Conflicts--Noise

Discuss each topic as it relates to good mental and physical health of a community's citizens. Discuss different crowded situations (ballgames, subways, classrooms, homes, etc.), environmental conflicts (those in which a poor environment contributes; i.e., racial differences in slums, traffic arguments, etc.), and human tolerance of noise, relating to causes and effects.

SOURCES: Ehrlich, 139-40, 203-07; Shepard, 77-92; Wagner, 192-95, 367-69; the reading (Day 12) in the 15-day unit.

5. Health

Discuss broadly how a poor natural and cultural environment has a negative effect on individual health, particularly related to crowding and pollution. Examine methods to improve individual and community health. Analyze modern medical practices (including drug use) and their relationship with environmental improvement, stability, or deterioration.

SOURCES: DeBell, 27-30; Ehrlich, 117-39, 148-51; Shepard, 223-29; Wagner, 201-10.

Week #14 PEOPLE AND CULTURAL PERSPECTIVES

1. Review

Review and answer students' questions dealing with PEOPLE AND SOCIETY.

2. Examination

This should cover the material discussed under PEOPLE AND SOCIETY.

3. Film

"Time of Man" or "The Sense of Wonder" and "The Edge of the Seal."

4. Environmental Encounters

Discuss the readings from the standpoint of personal enjoyment of nature, or what mental relaxation and physical gain man can derive from his experiences with the natural world. Discuss the students' personal experiences with nature (outside of urban living).

SOURCE: Shepard, 122-31, 133-39, 149-58.

5. Environmental Ethics

Discuss the readings from the standpoint of misconceptions which have entered our culture and how they can be eliminated or restructured, particularly those relating to growth equals good, change equals progress.

SOURCES: Dasmann, 273-87; DeBell, 31-51; Shepard, 333-37, 351-62, 395-401.

Week #15 CULTURAL PERSPECTIVES

1-5. Choose one of the four following books: Barry Commoner, The Closing Circle; Aldo Leopold, A Sand County Almanac; John Muir, The Mountains of California; or Henry David Thoreau, Walden. All are excellent and offer somewhat similar views of nature, man's place in it, and man's responsibility to the Earth. After assigning the book to the students three or four weeks in advance, examine and discuss it in detail during this week. Allow perhaps one or two days for in-class reading for those students who have not completed it by the start of the week.

There are several ways in which these books can be studied and taught as examples of environmental literature. One would be a fairly straightforward examination of events which unfold in the chapter-by-chapter narrative. Another would be a study of the major thematic elements and sub-elements of the work. Still another would be a character evaluation of those who appear in the work, assuming that the land itself, its wildlife, its plantlife, and the people (both as individuals and as a social whole) who inhabit the land could be considered as characters.

Any approach a teacher might take is acceptable. The important thing is the exposure the students and the teacher receive in reading and discussing at least one work from our environmental prophets.

Many important concepts are apparent in all four works worthy of classroom discussion. Some of them include:

1. The role of the climate in determining the flora and fauna of any area.
2. The changes in nature due to the calendrical cycle (notice also the chapter arrangements relative to this).
3. The role of the geologic past in determining the face of the earth described in each work.
4. The ecological relationships of the natural biological and botanical species in the geographical areas discussed.
5. The concepts of freedom, responsibility, balance, necessity, luxury, economy, wilderness, wildness, civilization, religion, complexity, simplicity, progress, wholeness, friendship, reality, cooperation, industry, etc.
6. The conflicts of social wants (consumption of natural resources and development of natural areas) and social needs (obtaining refreshment from nature and surviving).
7. The roles of industrialization, transportation, and commercialization, with regard to development and use of wild areas.
8. Man's love/hate and fear/trust ideas of nature.
9. The concept of getting a living.
10. The social structure and habits of all animals, including man.
11. The identification and cataloging of various plant and animal species.
12. The ethical approach to living with nature.

If possible, hold the class out-of-doors when discussing parts of the selected book. One important thing to remember is to include biographical sketches of the author chosen, making particular references to the social mood of the people and the historical events unfolding at the time the work was created. Include in your discussions comparisons between the author's factual and interpretative ideas of nature and the scholastic data covered thus far in the course. If time permits, choose two of the above books, one each as representative of the 19th and 20th centuries, and compare the ideas and concerns from an historical standpoint. A teacher may also wish to assign the books not chosen for the entire class to individual students for in-class reports.

Week #16 CULTURAL PERSPECTIVES

1. Frontier Development

Trace the spread of European-Americans across North America, from the 15th century to the present. Include in the discussion the economic, social, and psychological reasons for the westward migration. Note in particular the "cowboy mentality" or "frontier psychology" which accompanied the development in regard to land acquisition, natural resource use, removal and elimination of Indians, and establishment of social systems.

SOURCE: Any U.S. history textbook.

2. Industrial Development

Discuss the concurrent economic-commercial-industrial movement in the United States, taking into account the products produced and consumed, the natural resources used, the services offered, the wealth (economic, cultural, spiritual) of the people, pollution created, etc. Contrast industrialized nations with agricultural nations in terms of social development and economic development. Relate the idea of consumption of goods to the deterioration of the environment. Note the dramatic growth and continuing effect of technological and industrial development spurred by the nation's wars.

SOURCE: Any U.S. history textbook.

3. Contemporary Social Problems

Discuss America's society and its problems since World War II. Include racial, national, economic, and religious conflicts; city living, economic stability; mass education, popular styles; international involvement; mass communication; and other topics that directly or indirectly relate to environmental living.

SOURCE: Any U.S. history textbook; most current periodicals.

4. Historical Views

Discuss the White article, which traces our present ecological dilemma to our Judeo-Christian past. Have the students debate other factors which have led to our present environmental condition, particularly those discussed earlier this week or those deduced from the study of NATURAL RESOURCES or PEOPLE AND SOCIETY.

SOURCES: DeBell, 12-26; Shepard, 341-50. See also Lewis Moncrief, "The Cultural Basis for our Environmental Crisis," Science, vol. 170, pp. 508-12.

5. Environment, Future

Discuss the future of the Earth's environment and the survival of man, considering the possibility that nothing will be done to to correct our multiple environmental faults and considering the possibility that many constructive steps will be taken to correct past wrongs. Consider in particular the individual and social changes necessary in our culture and behavior which must precede any move toward environmental improvement; include also international cooperation, commercial redirection, etc. Catalog action steps necessary and develop a plan to improve your community's environment. Discuss the relevance of environmental education as a subject permeating all levels and disciplines in schools.

SOURCES: Dasmann, 331-42; DeBell, 96-101, 134-46, 153-60, 161-76; Ehrlich, 260-323; Shepard, 416-36; Wagner, 463-66.

Week #17 CULTURAL PERSPECTIVES

1. Environment, Future

Continue the discussions started during the last class period. Emphasize personal and community action which can be constructive in preventing environmental destruction and preserving and improving our local environment. Encourage the formation of recycling centers, municipal lobbying organizations, neighborhood clean-up campaigns, use of mass transportation instead of private automobiles, sound purchasing practices, etc. If available, show the recommended slide-tape show.

SOURCES: "Environmental Action Guide"--reading (Day 14) of the 15-day unit; DeBell, 285-95, 300-11, 317-33; slide-tape show, "Environmental Solutions," material developed on Day 40 of this course.

2. Environment, Occupations

Allow students to read chapter 1 and portions of chapter 2 of this handbook. Encourage students, particularly seniors, to choose careers which would improve the environment for everyone. Invite the school vocational counselor to speak on the subject. Point out the wide variety of environmental occupations, in terms of the nature of work, education, and training required; salary; conditions, etc. If available, show the recommended slide-tape show.

SOURCES: Chapters 1 and 2 of this handbook; slide-tape show, "Environmental Occupations."

3. Environment, Present Legislation

Discuss the past and present federal laws which protect and preserve our environment. Categorize by the resource they manage. Compare with your local and state laws. Discuss the past acceptance of these laws, the application of them, and the need for future legislation.

SOURCE: Chapter 4, VII, of this handbook.

4 & 5. Project Reports

Allow two days for the individuals and teams to give a class presentation of their particular projects, making sure they include their scientific methods, research techniques, operational techniques, and project results.

Week #18 FINAL EVALUATION AND NATURAL AREA STUDY

1. Review

Review and answer students' questions for the unit on CULTURAL PERSPECTIVES and whatever material from other units to be included in the final examination.

2. Final Examination

This should cover the material in the last unit as well as the fundamental concepts covered throughout the semester.

3. Film

"Multiply and Subdue the Earth." This is a natural and ecological film about nature, society, and problems of each. (This film runs 65 minutes.)

4 & 5. Natural Area/Wilderness Study

Take a field trip(s) to areas of natural interest (schoolgrounds, city parks, seashores, farmlands, national parks, etc.). Educational stress should be given to ecology study, the distribution and use of natural resources, pollution control, recycling, conservation, survival training, recreation and physical exercise, outdoor living, class and community cooperation, individual discipline and self-reliance, and enjoyment of the outdoors. If at all possible, expand this venture to the last entire day, overnight, or through the weekend. If the class is taught during the fall and you live in areas of severe winter weather, do this early in the semester. For those teachers who enjoy outdoor living, it will be a fine idea to take the students who have their parents' permission on several weekend camp-outs, nature hikes, or visits to urban recreational and education facilities. This may prove to improve considerably both the students' and the teachers' classroom performances and interest.

APPENDICES

Appendix 3-1: Reading--"An Environmental Ethic" [1]

Since year after year, our ecological problems are compounded, what Aldo Leopold states in his book, A Sand County Almanac, about the present state of environmental education is most relevant:

> Is something lacking in the content, as well? Is it difficult to give a fair summary of its content in brief form, but, as I understand it, the content is substantially this: obey the law, vote right, join some organizations and practice what conservation is profitable on your own land. The government will do the rest.
>
> Is not this formula too easy to accomplish anything worthwhile? It defines no right or wrong, assigns no obligation, calls for no sacrifice, implies no change in the current philosophy of values. In respect of land-use, it urges only enlightened self-interest. Just how far will such education take us?

My special concern is with Mr. Leopold's reference to a "change in the current philosophy of values." The following are my reasons.

Man is probably locked in a life or death struggle for survival. He is combating a monumental environmental backlash of pollution and contamination which may well be overwhelming. However, man's attempts at combating these problems based upon technological solutions and the old assumptions that caused the problems in the first place, although necessary for immediate health and safety, can only be a temporary delaying action. To secure long-term solution, man must deal with the cause of his problems. This cause is the lack of a broadly accepted environmental ethic dealing with how man perceives his role within the natural scheme of life.

How man perceives his role in the environment is then the root of our problems or the cause.

As man becomes aware of a perplexing question or problem in regards to his niche in the environment, either by revelation or education, he will seek an answer and, thus, make an evaluation. After an evaluation is reached, some course of action or response to the problem will ensue. It is these responses and actions that have caused our present environmental problems. If the revelation or education that I mentioned is changed, then man's actions also will hopefully change.

We cannot simply deal with the problems but must stimulate another evaluation based on sounder facts or a new ethic, free from technological myths, from theological prejudice and anthropocentric ideals. Biologist Garret Hardin, in "The Tragedy of the Commons," states that the "problem has no technical solution. It requires a fundamental extension in morality." Changes in morality connect the problems and causes with theology and philosophy.

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[1] From testimony of Ron Eber, Cochairman of Student's Environmental Confederation of California, before the House Select Subcommittee on Education's hearing on environmental education, May 1, 1970.

Also Leopold eloquently explains ecological philosophy by bringing together ethics and ecology. "This extension of ethics, so far studied only by philosophers, is actually a process in ecological evolution. Its sequences may be described in ecological as well as in philosophical terms."

What are these ecological terms and what is ecology? Ecology as the core of environmental education, is more than a system of nature. It is also one of human relationships. The ecology movement and environmental education must seek to do more than clean up rivers and the air or stop the use of pesticides. They must seek to stop all practices that degrade or destroy life and environments on the planet.

But what are the terms of ecologically relevant education? Paul Shepard, in his introduction to the book, The Subversive Science: Essays Toward the Ecology of Man, states:

> Ecology deals with organisms in an environment and with the processes that link organism and place. But ecology as such cannot be studied. Only organisms, earth, air and sea can be studied. It is not a discipline. There is no body of thought and technique which frame an ecology of man. It must be, therefore, a scope or a way of seeing. Such a perspective on the human situation is very old and has been part of philosophy and art for thousands of years. It badly needs attention and revival.

In our colleges, we must get away from specialized education when dealing with environmental problems. Biology shows us that all life is interdependent. Therefore, the perspective or outlook that Shepard speaks of can best be achieved by interdisciplinary studies. This would be a synthesis of the biological and environmental sciences with the social and cultural sciences.

So what I am advocating is an environmental education that is more than solution oriented, more than an education that will solve our short-term problems, more than an education of requirements to meet professional qualifications, but rather an education that has us ask, "So why do we do it? What good is it? Does it teach you anything, like determination, invention, or improvisation, foresight, hindsight, love, art, music, religion, strength or patience or accuracy or quickness or tolerance or how long is a day and how far is a mile, and how to rely on yourself?" So what is the philosophy that Shepard feels needs revival? What is the perspective that environmental education must have as its goal, its purpose and as its core concept?

Stephanie Mills puts it this way:

> To aspire to survival and to aspire to humanity are the paths. They are one and the same. All the logic, precision and practicality in the world can't save us if we lose our own soul. There can be no survival without passion. Passion for humanity, love of the earth, joy of existence and hope for the future. . . .

It is these concepts that environmental education must embrace. This kind of education will enable man, us, to perceive a sense of time and place within the context of all life.

To teach, in the classical sense of the term, this kind of education is impossible. It will take not just a qualified, degreed teacher, but a leader, one who understands the sense of the awe and wonder of life, not to teach it but to inspire, to help us experience the joy of existence and, thus, a will to survive.

Appendix 3-2: Reading--"The Biosphere"[1]

Because man is endowed with such remarkable ability to tolerate conditions profoundly different from the ones under which he evolved, the myth has grown that he can endlessly and safely transform his life and his environment by technological and social innovations; but this is not the case. On the contrary, the very fact that he readily achieves biological and socio-cultural adjustments to many different forms of stress and of undesirable conditions paradoxically spells danger for his individual welfare and for the future of the human race.

Man can achieve some form of tolerance to environmental pollution, excessive environmental stimuli, crowded and competitive social contacts, the estrangement of life from the natural biological cycles, and other consequences of life in the urban and technological world. This tolerance enables him to overcome effects that are unpleasant or traumatic when first experienced. But in many cases, it is achieved through organic and mental processes which may result in the chronic and degenerative disorders that so commonly spoil adult life and old age, even in the most prosperous countries.

Man can learn also to tolerate ugly surroundings, dirty skies, and polluted streams. He can survive even though he completely disregards the cosmic ordering of biological rhythms. He can live without the fragrance of flowers, the song of birds, the exhilaration of natural scenery and other biological stimuli of the natural world.

This loss of amenities and elimination of the stimuli under which he evolved as a biological and mental being may have no obvious detrimental effect on his physical appearance or his ability to perform as part of the economic or technologic machine. But the ultimate result can be and often is an impoverishment of life, a progressive loss of the qualities that we identify with humanness and a weakening of physical and mental sanity.

Air, water, soil, fire, the rhythms of nature and the variety of living things are of interest not only as chemical mixtures, physical forces, or biological phenomena; they are the very influences that have shaped human life and thereby created deep human needs that will not change in the foreseeable future. The pathetic weekend exodus to the country or beaches, the fireplaces in overheated city apartments, the sentimental attachment to animal pets or even to plants testify to the persistence in man of biological and emotional hungers that developed during his evolutionary past and he cannot outgrow.

Like Anteus of the Greek legend, man loses his strength when his feet are off the ground. . . .

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[1] Excerpt from article by Rene Dubos in Unesco Courier (January 1969).

The environments men create through their wants constitute to a very large extent the formula of life they transmit to succeeding generations. Thus, in addition to affecting present-day life, the characteristics of the environment condition young people and thereby determine the future of society. It is unfortunate therefore that we know so little and make so little effort to learn how the total environment affects the physical and mental development of children, and how much of the influence persists in adult life.

There is no doubt that the latent potentialities of human beings have a better chance of being realized when the total environment is sufficiently diversified to provide a variety of stimulating experiences, especially for the young. As more persons find the opportunity to express a larger percentage of their biological endowment under diversified conditions, society becomes richer and civilizations continue to unfold.

In contrast, if the surroundings and ways of life are highly stereotyped, the only components of man's nature that can become expressed and flourish are those adapted to the narrow range of prevailing conditions.

Historically, man was very slow to expand his horizons and develop his full genetic potential. Thus, surrounding early man with nature does not seem to guarantee a rich, diverse existence. Furthermore, in some present rural areas of the developed countries, man has produced a monotony of both crops and culture that stifles human development.

The present trends of life in prosperous countries are usually assumed to represent what people want; but in reality the trends are determined by what is available for choice. What people come to want is largely determined by the choices readily available to them early in life. Many children growing up in some of the most prosperous suburbs of industrialized countries may suffer from a critical deprivation of experiences, and this determines the triviality of their adult lives. In contrast, some poor areas of the world provide human environments that are so stimulating and diversified that many distinguished adults emerge from them despite the economic poverty of their early years.

There is no doubt, in any case, concerning the sterilizing atmosphere of many modern housing developments which are sanitary and efficient, but inimical to the full expression of human potentialities. All over the world, many of these developments are planned as if their only function was to provide disposable cubicles for dispensable people. Irrespective of their genetic constitution, most young people raised in such a featureless environment, and limited to a narrow range of life experiences, will suffer from a kind of deprivation that will cripple them intellectually and mentally.

In judging the human quality of an environment, [we must] keep in mind that passive exposure to stimuli is not enough to elicit individual development. The stimulus becomes formative only if the organism is given a chance to respond to it actively and creatively. Amusement parks and zoological gardens, richly endowed as they may be, are no substitute for situations in which the developing child can gain direct experience of the world through active participation. Juvenile delinquency is probably caused to a very large extent by the failure of the modern world to provide opportunities for the creative expression of physical and mental [vigor] during a human being's most active period of development.

Man has been highly successful as a biological species because he is extremely adaptable. He can hunt or farm, be a meat-eater or a vegetarian, live in the mountains or by the seashore, be a loner or a team member, function under aristocratic, democratic, or totalitarian institutions, but history shows also that societies that were once efficient became highly specialized [and] rapidly collapsed when conditions changed. A highly specialized society, like a narrow specialist, is rarely adaptable.

Cultural homogenization and social regimentation, resulting from the creeping monotony of overorganized and overtechnicized life, standardized patterns of education, mass communication and passive entertainment, will make it progressively more difficult to exploit fully the biological richness of the human species, and may handicap the further development of civilization.

We must shun uniformity of surroundings as much as absolute conformity in [behavior] and tastes. We must strive instead to create as many diversified environments as possible. Richness and diversity of physical and social environments constitute a crucial aspect of functionalism, whether in the planning of rural and urban areas, the design of dwellings, or the management of individual life.

Diversity may result in some loss of mechanical and administrative efficiency and will certainly increase stresses, but the more important goal is to provide the many kinds of soil that will permit the germination of the seeds now dormant in man's nature. . . .

Until now, man has behaved as if the areas available to him were unlimited, and if these were infinite reservoirs of air, soil, water, and other resources. He could do this with relative impunity in the past because there was always some other place where he could go, start a new life, and engage in any kind of adventure that he chose.

Since the evolutionary and historical experiences of man are woven in his mental fabric, he naturally finds it difficult not to behave as a nomad and hunter. It is not natural for him to rest quietly in a corner of the earth and husband it carefully. His thoughtlessness in provoking ecological situations that are potentially dangerous originates partly from the fact that he has not yet learned to live within the constraints of his spaceship.

The ecological attitude is so unfamiliar, even to many scientists, that it is often taken to imply acceptance of a completely static system. Students of human sociology have expressed concern lest the ecologist's professional interest in the well-balanced, smoothly functioning, steady-state ecosystem of the pond be extrapolated uncritically to the whole earth and its human population. They are right in emphasizing that man's relation to his total environment cannot be regarded as a steady-state ecosystem because this would imply that the human adventure has come to an end.

The physical forces of the environment are forever changing, slowly but inexorably. Furthermore, all forms of life including human life are continuously evolving and thereby making their own contribution to environmental changes. Finally it seems to be one of man's fundamental needs to search endlessly for new environments and for new adventures. There is no possibility therefore of maintaining a status quo.

Even if we had enough learning and wisdom to achieve at any given time a harmonious state of ecological equilibrium between mankind and the other components of the spaceship Earth, it would be a dynamic equilibrium, and this would be compatible with man's continuing development.

The important question is whether the interplay between man and his natural and social surroundings will be controlled by blind forces as seems to be the case for most if not all animal species, or whether it can be guided by deliberate, rational judgments. . . .

On the one hand, the genetic endowment of Homo sapiens has changed only in minor details since the Stone Age, and there is no chance that it can be significantly, usefully, or safely modified in the foreseeable future. This genetic permanency defines the human race, and determines the physiological limits beyond which human life cannot be safely altered by social and technological innovations. In the final analysis, the frontiers of cultural and technological development are determined by man's own biological frontiers and therefore by the genetic constitution he acquired during the evolutionary past.

On the other hand, mankind has a large reserve of potentialities that become expressed only to the extent that circumstances are favorable. The physical surroundings condition not only the biological aspects of phenotypic expressions but also their mental aspects. Environmental planning can thus play a key role in enabling human beings to realize their potentialities. One can take it for granted that there is a better chance to convert these potentialities into actual realizations when the physical environment is sufficiently diversified to provide a variety of stimulating experiences and opportunities, especially for the young.

Any change in mental attitude and in ways of life becomes incorporated in the human group concerned through socio-cultural mechanisms, and from then on it conditions the future development of the group. Socio-cultural evolution is as much under the influence of the environment as is biological evolution, and almost as irreversible.

Planning for the future demands an ecological attitude based on the assumption that man will continuously bring about evolutionary changes through his creative potentialities. The constant interaction between man and environment inevitably implies continuous alterations of both--alterations that should always remain within the constraints imposed by the laws of Nature and by the unchangeable biological and mental characteristics of man's nature.

Chapter 4

A SELECTED BIBLIOGRAPHY FOR ENVIRONMENTAL EDUCATION

A SELECTED BIBLIOGRAPHY FOR ENVIRONMENTAL EDUCATION

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INTRODUCTION

This bibliography is intended for use in secondary schools and is designed primarily for curriculum planners, librarians, life and social sciences instructors, and individual students. Its organization and content are designed to complement the two curriculum schedules in the preceeding chapter. It is hoped that this will serve as a selective guide for all schools wishing to start or upgrade their holdings in environmental literature.

Several criteria were used in determining the selections included. The most significant being that the works and articles chosen be designed so that most students will find them interesting and comprehensible. The selections were also chosen as representative of national interest and phenomena rather than local ones. Finally, the selections were made to include material which broadly covers a particular subject or field rather than a narrow specialty.

I. GENERAL -- Environment, Ecology, Conservation

A. Textbooks and Anthologies

Anderson, Walt. Editor. 1970. POLITICS AND ENVIRONMENT: A READER IN ECOLOGICAL CRISIS. Pacific Palisades, California: Goodyear Publishing Company, Inc. A collection of articles: The Urban Environment, The Rural Environment, Environmental Policy, Nature and Human Nature, Population, Politics, and Pollution.

Benarde, Melvin A. 1970. OUR PRECARIOUS HABITAT. AN INTEGRATED APPROACH TO UNDERSTANDING MAN'S EFFECT ON HIS OWN ENVIRONMENT. New York: W. W. Norton. $2.95.

Bresler, Jack B. Editor. 1969. ENVIRONMENTS OF MAN. Reading, Massachusetts: Addison-Wesley. $4.25. An anthology of 24 articles on a wide variety of environmental topics.

CONSERVATION IN THE UNITED STATES: A DOCUMENTARY HISTORY, 5 volumes. 1971. New York: Van Nostrand Reinhold Company. $150. A complete reference library documenting the historical development of conservation policies in water, air, land, minerals, and recreation. These books present guidelines to roles of the individual, school, and industry in conserving our natural resources. Described by the publishers, the set is "the most comprehensive study ever compiled on the history of conservation policies in the United States."

Cox, G. Editor. 1969. READINGS IN CONSERVATION ECOLOGY. New York: Appleton, Century, Crofts.

Crosson, Frederick J. Editor. 1967. SCIENCE AND CONTEMPORARY SOCIETY. Notre Dame: University of Notre Dame. $7.95. Ten essays on literature, philosophy, religion, international affairs, human welfare, education, man's future, and science.

Darling, F. and John P. Milton. Editors. 1966. FUTURE ENVIRONMENTS OF NORTH AMERICA. New York: Natural History. $12.50.

Dasmann, Raymond F. 1968. ENVIRONMENTAL CONSERVATION. 2nd edition. New York: John Wiley. $4.95. Excellent consideration of man's environment.

DeBell, Garrett. Editor. 1970. THE ENVIRONMENTAL HANDBOOK. New York: Ballantine Books. $0.95. "To serve as a source of ideas and tactics for the 1970 teach-in, this handbook brings together students, scientists, writers and others to focus on some of the major problems of our deteriorating environment, explains the nature of ecology, and, most importantly, suggests action that can be taken right now in any community by any individual."

Detwyler, Thomas R. 1971. MAN'S IMPACT ON ENVIRONMENT. New York: McGraw-Hill.

Disch, Robert. Editor. 1970. THE ECOLOGICAL CONSCIENCE. VALUES FOR SURVIVAL. Englewood Cliffs, New Jersey: Prentice-Hall. $5.95, $2.45. Sixteen excellent essays.

Ehrlich, Paul R. and Anne H. Ehrlich. 1970. POPULATION RESOURCES ENVIRONMENT. San Francisco: W. H. Freeman. $8.95. An excellent source.

Ewald, William R., Jr. Editor. 1967. ENVIRONMENT FOR MAN: THE NEXT FIFTY YEARS. Bloomington, Indiana: Indiana University Press. $6.95, $2.95.

Ewald, William R., Jr. Editor. 1968. ENVIRONMENT AND CHANGE: THE NEXT FIFTY YEARS, and ENVIRONMENT AND POLICY: THE NEXT FIFTY YEARS. Bloomington, Indiana: Indiana University Press. $4.95 each. These two volumes and the one published in 1967 form a valuable collection of readings by outstanding authorities on environmental questions.

Gerking, Shelby D. 1969. BIOLOGICAL SYSTEMS. New York: Saunders. $8.50.

Hardin, G. Editor. 1969. SCIENCE CONFLICT AND SOCIETY: READINGS FROM SCIENTIFIC AMERICAN. San Francisco: W. H. Freeman. $5.75.

Highsmith, Richard M., et al. 1969. CONSERVATION IN THE UNITED STATES. 2nd edition. Rand McNally. $9.95.

Jarrett, H. Editor. 1966. ENVIRONMENTAL QUALITY IN A GROWING ECONOMY. Baltimore: Johns Hopkins Press. An interesting collection, particularly the article by Boulding--"The Economics of the Coming Spaceship Earth."

Johnson, Cecil E. Editor. 1970. ECOCRISIS. New York: John Wiley. Sixteen articles on the environment, population, pollution, war, and prospects for the future.

Johnson, H. D. Editor. 1970. NO DEPOSIT--NO RETURN. Reading, Massachusetts: Addison-Wesley. An anthology of papers later presented to UNESCO.

Kormondy, E. 1969. CONCEPTS OF ECOLOGY. New York: Prentice-Hall. $2.95.

Love, Rhoda M. and Glen A. Love. Editors. 1970. ECOLOGICAL CRISIS. READINGS FOR SURVIVAL. New York: Harcourt, Brace, Jovanovich. $3.95. A useful selection of papers.

Nash, Roderick. Editor. 1968. THE AMERICAN ENVIRONMENT: READINGS IN THE HISTORY OF CONSERVATION. Reading, Massachusetts: Addison-Wesley. This traces Nash's observations about American ideas of environment and conservation through official and unofficial writings.

National Academy of Sciences. 1969. RESOURCES AND MAN. San Francisco: W. H. Freeman. $5.95, $2.95. Presents an introduction to the problem of resource adequacy. Emphasis is placed on issues that are central to a realistic assessment of the problem rather than on detailed estimates or projections. Coverage includes the ecology and geography of resources in relation to man, demographic trends, and the adequacy of food, mineral, and energy resources to meet current and expected pressures.

National Wildlife Federation. BY WHICH WE LIVE. Washington, D.C.: Educational Servicing Section. Single copy free, additional copies 25¢. Collection of essays and articles on the basic problems of resource conservation.

Nickelsburg, Janet. 1969. ECOLOGY: HABITATS, NICHES AND FOOD CHAINS. (Introducing Modern Science Series.) New York: Lippincott. $4.50.

Odum, E. 1969 (London). 1970 (U.S.A.). NATURE'S NETWORK: THE STORY OF ECOLOGY. Nature and Science Library. $6.95. Technical and thorough. Best used as reference or selective reading. Excellent graphs.

Shepard, Paul and Daniel McKinley. Editors. 1969. THE SUBVERSIVE SCIENCE. ESSAYS TOWARD AN ECOLOGY OF MAN. Boston: Houghton-Mifflin. $8.95, $5.95. Excellent collection of readings on human ecology.

Smithsonian Institution. 1967. THE FITNESS OF MAN'S ENVIRONMENT. Washington, D.C.: Smithsonian Institution. $6.50. Papers by world authorities on the quality of man's environment.

Swatek, Paul. 1970. THE USER'S GUIDE TO THE PROTECTION OF THE ENVIRONMENT. New York: Ballantine. $1.25.

U.S. Council on Environmental Quality. 1970. ENVIRONMENTAL QUALITY: FIRST ANNUAL REPORT. Washington, D.C.: Government Printing Office. $1.75. Seeks to describe the conditions of our environment, and to identify major trends, problems, actions under way, and opportunities for the future. The report reviews Federal legislation and focuses on water, air, weather and climate, solid wastes, noise, pesticides and radiation, population, and land use.

Wagner, Richard W. 1971. ENVIRONMENT AND MAN. New York: W. W. Norton. $7.50. A fine textual source.

B. Periodicals (A Listing)

AUDUBON. 1130 Fifth Avenue, New York, New York 10028. $8.50 a year. Emphasis on wildlife and nature.

BIOSCIENCE. American Institute of Biological Sciences, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016. Monthly. $12 a year. Emphasis is on application of biological sciences to man's living conditions, i.e., hunger, pollution, pesticides. Written in popular style. For senior high school to develop an awareness of the importance of the field of biological sciences and interest in it.

DAEDALUS. American Academy of Arts and Sciences, 280 Newton Street, Brooklyn Station, Boston, Massachusetts 02146. $7.50 a year. Four issues a year, each 200-300 pages. Each issue generally considers a single topic in great depth, such as "Color and Race," "Utopia," "Science and Culture," "Science and Technology in Contemporary Society," "Population," etc.

ECOLOGY TODAY. Box 180, West Mystic, Connecticut 06388. It will alternate with a bimonthly newsletter. Annual subscription for both is $6.00.

ENVIRONMENT. Committee for Environmental Information, 438 North Skinner Boulevard, St. Louis, Missouri 63130. 10 issues. Annual subscription is $8.50. The CEI has been outstanding in drawing attention to pollution and the misuse of the environment.

ENVIRONMENTAL EDUCATION. Dembar Educational Research Service, Box 1605, Madison, Wisconsin 53701. Quarterly. Annual subscription is $7.50 and $5.00 (student). Research and development in conservation communications. The magazine began in the fall of 1969. For mature students and teachers.

F.A.O. REVIEW. Food and Agriculture Organization of the United Nations. Bimonthly. $2.50. "A well-printed, beautifully illustrated journal, this is concerned with studies of hunger and poverty throughout the world . . . Particularly useful for information in activities in smaller countries. Should prove popular for browsing and as a source of reliable material for student papers." -- Magazines for School Libraries.

NATION'S CITIES. 1612 K Street, N.W., Washington, D.C. 20006. Monthly. $6.00 a year. Short articles on transit facilities, urban design, area planning, water supply housing projects, slum clearance, and racial riots. Official publication of the National League of Cities. For senior high.

NATIONAL GEOGRAPHIC SOCIETY. 17th and M Streets, N.W., Washington, D.C. $9.00 a year. Has lately changed focus from resource development to resource preservation.

NATURE STUDY. American Nature Study Society, J. A. Gustafson, R.D. 1, Homer, New York 13077. $5.00 a year. Quarterly.

OUR ENVIRONMENT. Issues for Today Series. 1970. Pamphlets. Reader's Digest Services. 25¢ each. "World Population: Is the Battle Lost" by Paul R. Ehrlich. "Confessions of a Polluter" by Arthur Godfrey. "He Brought a Stream Back to Life" by Roul Tunley. "Can Our Rivers Stand the Heat?" by W. Langewiesche. Compact articles, good for study. Asks central, critical comparative questions in teacher's guides. Poses problems, not offering solutions.

SCIENCE. American Association for the Advancement of Science. 1515 Massachusetts Avenue, N.W., Washington, D.C. 20005. Weekly. Annual subscription $16. Most useful source of current information.

SCIENTIFIC AMERICAN. 415 Madison Avenue, New York, New York 10017. Monthly. Annual subscription $10. Many fine general articles and some current events, particularly useful for schools.

THE LIVING WILDERNESS. Wilderness Society, 729 15th Street, N.W., Washington, D.C. 20005. Quarterly. Features articles evaluating special environmental problems and news.

THE SIERRA CLUB BULLETIN. Sierra Club, 1050 Mills Tower, San Francisco, California 94104. Monthly. $5.00 annually. General environmental articles, wonderful photographs, and a "Washington Report."

Other national periodicals which frequently carry environmental articles include:

(1) AMERICAN HERITAGE
(2) AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES JOURNAL
(3) AMERICAN SCIENTIST
(4) ART EDUCATION JOURNAL
(5) ATLANTIC MONTHLY
(6) BEHAVIOR AND ENVIRONMENT
(7) ENVIRONMENTAL SCIENCE AND TECHNOLOGY
(8) HARPER'S
(9) LIFE
(10) NATIONAL ACADEMY OF SCIENCES BULLETIN
(11) NATIONAL PARKS AND CONSERVATION MAGAZINE
(12) NATURAL HISTORY
(13) NEWSWEEK
(14) NEW YORKER

(15) NEW YORK TIMES MAGAZINE
(16) OUTDOOR LIFE
(17) SATURDAY REVIEW
(18) SOCIETY OF CIVIL ENGINEERING JOURNAL
(19) SOCIETY OF NATURAL RESOURCES JOURNAL
(20) SPORTS AFIELD
(21) SPORTS ILLUSTRATED
(22) SUMMIT MAGAZINE
(23) TIME

C. Other Views (Cultural, Scientific, Social, etc.)

Abbey, Edward. 1968. DESERT SOLITAIRE. New York: McGraw-Hill. $5.95. The romance and ecology of a desert.

Anderson, Charles R. Editor. 1971. THOREAU'S WORLD. MINIATURES FROM HIS JOURNAL. Englewood Cliffs, New Jersey: Prentice-Hall. $10.

Baker, H. G. 1965. PLANTS AND CIVILIZATION. New York: Wadsworth. Baker lucidly discusses the importance of plants to man's social and economic development and the equally important consideration of man's role in the modification and distribution of plants.

Barket, Roger G. 1968. ECOLOGICAL PSYCHOLOGY. CONCEPTS AND METHODS FOR STUDYING THE ENVIRONMENT OF HUMAN BEHAVIOR. Stanford, California: Stanford University Press. $7.50.

Bates, Marston. 1964. MAN IN NATURE. Englewood Cliffs, New Jersey: Prentice-Hall. $1.95.

Benjamin, H. C. 1965. SCIENCE, TECHNOLOGY, AND HUMAN VALUES. Columbia: University of Missouri Press.

Black, C. E. 1966. THE DYNAMICS OF MODERNIZATION. New York: Harper & Row. $1.60.

Black, John. 1970. THE DOMINION OF MAN: THE SEARCH FOR ECOLOGICAL RESPONSIBILITY. Chicago: Aldine. $7.50.

Bell, Daniel. Editor. 1969. TOWARD THE YEAR 2000: WORK IN PROGRESS. Boston: Beacon Press. $3.50.

Boffey, Philip M. 1970. "Hiroshima/Nagasaki. Atomic Bomb Casualty Commission Perseveres in Sensitive Studies." Science, 168: 679-683.

Briggs, A. 1963. "Technology and Economic Development." Scientific American, September: 52-61.

Bronowski, J. 1956. SCIENCE AND HUMAN VALUES. New York: Harper & Row. $1.25.

Brooks, Harvey and Raymond Bowers. 1970. "The Assessment of Technology." Scientific American, February: 13-21. A summary of a National Academy of Sciences study on "Technology."

Bryerton, Gene. 1970. NUCLEAR DILEMMA. New York: Ballantine. $1.25.

Butterfield, Herbert. 1960. "The Scientific Revolution." Scientific American, September: 173-192.

Caldwell, Lynton Keith. 1970. ENVIRONMENT: A CHALLENGE FOR MODERN SOCIETY. Garden City, New York: The Natural History Press. Written for the general reader, rather than the environmental specialist, the purpose of this book is to help the reader understand why new patterns of individual behavior and social action in relation to the environment have become imperative to human welfare.

Citizens Advisory Committee on Environmental Quality. 1970. COMMUNITY ACTION FOR ENVIRONMENTAL QUALITY. Washington, D.C.: Government Printing Office. A guide for citizens who want to participate in practical action to make their communities better places to live in. Concentrates on the principal approaches, how each works, how they can work together, and what organizations and agencies one can go to for further help.

Citizens Advisory Committee on Recreation and Natural Beauty. 1968. CITIZEN MANUAL FOR COMMUNITY ACTION. Washington, D.C.: Government Printing Office. Single copy free from the committee (1700 Pennsylvania Avenue, Washington, D. C. 20006). 40¢. Covers action for open space and recreation, landscape, cleaning the air, and procedures for action.

Coale, Ansley J. 1970. "Man and His Environment." Science, 170: 132-136. Economics rather than population threatens the quality of American life. An excellent summary.

Cole, LaMont C. 1968. "Can the World Be Saved?" Bioscience, 18: 679-684.

Commoner, Barry. 1966. SCIENCE AND SURVIVAL. New York: Viking Compass Edition. $1.35.

Commoner, Barry. 1971. THE CLOSING CIRCLE. New York: Alfred Knopf. $6.95.

Congressional Quarterly. 1970. CHALLENGES OF THE 1970'S. Washington, D.C.: Congressional Quarterly, Incorporated. $3.95.

Congressional Quarterly. 1969. CULTURAL LIFE AND LEISURE IN AMERICA. Washington, D.C.: Congressional Quarterly, Incorporated. $3.95. Arts and activities.

Congressional Quarterly. 1970. MAN'S CONTROL OF THE ENVIRONMENT. Washington, D.C.: Congressional Quarterly, Incorporated. $4.00. Politics and environmental action.

Congressional Quarterly. 1971. MODERN MAN. Washington, D.C.: Congressional Quarterly, Incorporated. $3.95. Humanism, urbanization, revolution, psychology, etc.

Congressional Quarterly. 1971. POLITICS IN AMERICA. Washington, D.C.: Congressional Quarterly, Incorporated. $4.00. The politics and issues of the post-war years.

Congressional Quarterly. 1971. THE SCIENTIFIC SOCIETY. Washington, D.C.: Congressional Quarterly, Incorporated. $3.95. Science and morals must progress together.

Congressional Quarterly. 1968. WORLD IN FERMENT. Washington, D.C.: Congressional Quarterly, Incorporated. $3.95. Planetary political and environmental problems.

Crowe, B. L. 1969. "The Tragedy of the Commons Revisited." Science, 166: 1103-1107. Depressing evaluation of the chances of dealing politically with the problems of the commons; refers to Hardin (1968).

Curtis, Richard and Elizabeth Hogan. 1969. THE PERILS OF THE PEACEFUL ATOM: THE MYTH OF SAFE NUCLEAR POWER PLANTS. New York: Doubleday. $4.59.

Dales, J. H. 1968. POLLUTION, PROPERTY, AND PRICES. Toronto: University of Toronto Press.

Darling, Lois and Louis. 1968. PLACE IN THE SUN: ECOLOGY AND THE LIVING WORLD. New York: Morrow. $3.95.

Darwin, Charles. 1958. THE ORIGIN OF THE SPECIES. New York: Mentor. $1.25.

Dasmann, Raymond F. 1970. A DIFFERENT KIND OF COUNTRY. New York: Macmillan. This raises important questions about the dependence of freedom on a varied environment and the role of the citizen in asserting his rights to such environmental freedom.

Defoe, Daniel. 1964. ROBINSON CRUSOE. New York: Mentor. $0.95.

Devoto, Bernard. 1952. THE COURSE OF THE EMPIRE. Boston: Houghton-Mifflin. $21.65.

Dubos, Rene. 1969. A THEOLOGY OF THE EARTH. Washington, D.C.: Government Printing Office. $0.30. A lecture given at the Smithsonian Institute.

Dubos, Rene. 1965. "Humanistic Biology." American Scientist, 53: 4-19.

Dubos, Rene. 1970. "Mere Survival Is Not Enough for Man." Life, July 24.

Dubos, Rene. 1968. SO HUMAN AN ANIMAL. New York: Scribners. How man is shaped by his environment, how we can control such environmental forces as urbanization and technology, and how we need urgently to study the effects of these forces if we are to enhance our humanness. 1969 Pulitzer Prize Winner.

Eiseley, Loren. 1966. THE FIRMAMENT OF TIME. New York: Ahteneum.

Eiseley, Loren. 1970. THE INVISIBLE PYRAMID. New York: Scribner's.

Eiseley, Loren. 1964. "The Uncomplicated Man." Harper's, March.

Eiseley, Loren. 1969. THE UNEXPECTED UNIVERSE. New York: Harcourt, Brace & World.

Eisenhower, Dwight D. 1965. WAGING PEACE 1956-1961. THE WHITE HOUSE YEARS. Garden City, New York: Doubleday. Includes the speech on the military-industrial complex, "Farewell Speech to the Nation."

Ehrensaft, Philip and Amitai Etzioni. Editors. 1969. ANATOMIES OF AMERICA. SOCIOLOGICAL PERSPECTIVES. New York: Macmillan. $4.95. Articles on politics, labor, race, class, religion, education, cities, deviance, and demography.

Ehrlich, Paul R. and Richard L. Harriman. 1971. HOW TO SURVIVE. A PLAN TO SAVE SPACESHIP EARTH. New York: Ballantine, $1.25.

Elder, Frederick. 1970. CRISIS IN EDEN. Nashville: Abingdon Press. $3.95. An inquiry into the religious man's attitudes toward nature.

Environmental Action Guide. 1970. EARTH DAY--THE BEGINNING. New York: Bantam. $1.25.

Faltermayer, E. 1969. REDOING AMERICA. New York: Collier. $1.95.

Ferkiss, Victor C. 1969. TECHNOLOGICAL MAN: THE MYTH AND THE REALITY. New York: Mentor. $0.95.

Forbes, R. J. 1968. THE CONQUEST OF NATURE: TECHNOLOGY AND ITS CONSEQUENCES. New York: Praeger. $1.25.

Fortune. 1970. THE ENVIRONMENT. New York: Harper & Row.

Fromm, Erich. 1968. THE REVOLUTION OF HOPE: TOWARD A HUMANIZED TECHNOLOGY. New York: Harper & Row.

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Galbraith, John Kenneth. 1958. THE AFFLUENT SOCIETY. New York: New American Library. New York: Mentor. $0.95. The history of economic theory and society.

Galbraith, John Kenneth. 1967. THE NEW INDUSTRIAL STATE. New York: Signet Books. $1.25.

Gardner, John. 1964. SELF-RENEWAL: THE INDIVIDUAL AND THE INNOVATIVE SOCIETY. New York: Harper & Row.

Goodman, P. 1966. GROWING UP ABSURD. New York: Vintage. $1.45.

Goodman, Paul. 1962. UTOPIAN ESSAYS AND PRACTICAL PROPOSALS. New York: Vintage Books. $1.45.

Gouldner, Alvin W. 1970. THE COMING CRISIS OF WESTERN SOCIOLOGY. New York: Basic Books. $12.50. Stated to be one of the most important books in sociology to appear in the past decade.

Handler, Philip. 1971. "The Federal Government and the Scientific Community." Science, 171: 144-151. By the President of the National Academy of Sciences.

Hardin, Garrett. 1968. "The Tragedy of the Commons." Science, 162: 1243-1248. See also Crowe (1969) on the necessity of giving up some individual freedoms, particularly the freedom to multiply.

Haskins, Caryl P. 1970. "The Humanities and the Natural Sciences." American Scientist, 58: 23-33.

Holton, Gerald. Editor. 1965. SCIENCE AND CULTURE. Boston: Houghton-Mifflin. $6.00, $2.45 (Beacon Press).

Hutchins, R. 1953. UNIVERSITY OF UTOPIA. University of Chicago Press. $1.50.

Huxley, Aldous. 1960. BRAVE NEW WORLD. New York: Harper & Row. $2.75.

Huxley, Aldous. 1963. LITERATURE AND SCIENCE. New York: Harper & Row.

Jeffers, Robinson. 1965. SELECTED POEMS. New York: Vintage Books. $1.45. An excellent collection of poetry on man and the environment.

Johnson, Cecil E. Editor. 1968. SOCIAL AND NATURAL BIOLOGY. Princeton, New Jersey: D. Van Nostrand. Johnson's book is unexcelled as a collection of environmental interpretation. Articles by: L. S. B. Leakey, Aldous Huxley, Garrett Hardin, John Steinbeck, Rachel L. Carson, John Muir, John Burroughs, Henry David Thoreau, Loren Eiseley, and others.

Krutch, Joseph Wood. THE DESERT YEAR. New York: Viking Press. $1.65.

THE BEST NATURE WRITING OF JOSEPH WOOD KRUTCH. 1970. New York: Pocket Books.

Leopold, Aldo. 1966. A SAND COUNTY ALMANAC, WITH OTHER ESSAYS ON CONSERVATION FROM ROUND RIVER. Oxford. $6.50.

Libby, L. M. Editor. 1970. FIFTY ENVIRONMENTAL PROBLEMS OF TIMELY IMPORTANCE. Santa Monica, California: Rand Corporation. This surveys some of the most recognizable and pressing problems of the environment, and includes comments on them from the current literature.

Lillard, Richard G. 1966. EDEN IN JEOPARDY. MAN'S PRODIGAL MEDDLING WITH HIS ENVIRONMENT: THE SOUTHERN CALIFORNIA EXPERIENCE. New York: Knopf. $6.95.

MacLeish, Archibald. 1968. "The Great American Frustration." Saturday Review, 13 July: 13-16. The adverse effects of science and technology on our lives and environment.

Manier, Edward. 1970. "Biology and the Individual in Society." Bioscience, 20: 104-108. Moral questions arising from attempts to control human evolution.

Marchant, Ronald A. 1968. MAN AND BEAST. New York: Macmillan. $4.95.

Marx, Leo. 1970. "American Institutions and Ecological Ideals." Science, 170: 945-952. Scientific and literary views of our reckless life style are merging.

Mathewson, J. H. 1962. "Science for the Citizen: An Educational Problem." Science, 138: 1375-1379.

Means, Richard L. 1969. THE ETHICAL IMPERATIVE. THE CRISIS IN AMERICAN VALUES. Garden City, New York: Doubleday. $6.95. A thoughtful consideration of many of man's problems of living with himself, his fellow men, and nature. Cites other works and views.

Medawar, P. B. 1959. THE FUTURE OF MAN. New York: Mentor. $0.60. Speculations on genectics.

Mesthene, Emmanuel G. 1970. TECHNOLOGICAL CHANGE. ITS IMPACT ON MAN AND SOCIETY. Cambridge: Harvard University Press. $4.95. Includes a fine bibliography.

Milne, Lorus J. and Margery Milne. 1967. PATTERNS OF SURVIVAL. Englewood Cliffs, New Jersey. $7.95.

Mitchell, John G. and Constance L. Stallings. Editors. 1970. ECOTACTICS: THE SIERRA CLUB HANDBOOK FOR ENVIRONMENTAL ACTIVISTS. New York: Pocket Books. $0.95.

Moncrief, Lewis W. 1970. "The Cultural Basis for our Environmental Crisis." Science, 170: 508-512. See also Lynn White (1967).

Montagu, Ashley. 1968. MAN OBSERVED. Putnam. $6.95.

Mumford, Lewis. 1970. THE MYTH OF THE MACHINE. VOLUME II. THE PENTAGON OF POWER. New York: Harcourt, Brace & Javanovich. $12.95. Blame for our state of affairs is laid largely at the feet of science rather than on those who avidly seek the rewards of technology.

Muir, John. 1961. THE MOUNTAINS OF CALIFORNIA. New York: Anchor Books. $1.45. The geology and beauty of California by the premier Western conservationist.

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  FISH AND WILDLIFE (#21).
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  INSECTS (#41). Worms and insects harmful to man, animals, and plants.
  IRRIGATION, DRAINAGE, AND WATER POWER (#42).
  NATIONAL PARKS (#35). Historic sites, national monuments.
  OCCUPATIONS (#33A). Professions and job descriptions.
  PLANTS (#44). Culture, grading, marketing, and storage of fruits, vegetables, grass, and grain.
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  No. 4. MAN: AN ENDANGERED SPECIES. 1968. $1.50.
  No. 5. IT'S YOUR WORLD: THE GRASSROOTS CONSERVATION STORY. 1969. $2.00.
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V. MULTIMEDIA MATERIALS

A. Films

"America's Wonderland/The National Parks." National Geographic Society. McGraw-Hill #648069, Film-C/16mm/53 minutes/ 1&2, S-$610, R-$46. Survey: Hawaii volcanoes National Park to Yellowstone, Grand Canyon to Virgin Islands. Conservation that works.

"Air Pollution and You." Current Affairs Films. U.S. Department of HEW/ #F-1528-X, Filmstrip/C/35mm, FL. 46-frame filmstrip with captions and outlines the basic problem of air pollution, its principal effects on health and property, some approaches to its control, and the Federal program.

"Air Pollution: Take a Deep Deadly Breath." ABC-TV. Complete--#M-1540-X, Film C/16mm/54 minutes, FL. Unusual presentation of the problem of pollution-interviews with people from all walks of life, punctuated with a variety of pollution sources.

Association-Sterling Films. Catalog of 27 conservation-ecology films includes the well-known Sierra Club film library. 16mm sound. Sample titles: "1985," "Redwoods--Saved?," "Nature Next Door." Free loan, sale and rental.

"Bulldozed America." CBS-TV. National Audubon Society. Film-BW/16mm/ 27 minutes, R-$10. Some of the most serious threats to natural beauty and wilderness. The redwoods, mining, urban sprawl, billboards, air and water pollution, and damming wild rivers.

"Challenge for Urban Renewal." NBC. Films, Inc./C#33-0023; BW #33-0024, Film-C/B&W/16mm/28 minutes, S-C=$327.50, BW=$167.50. Illustrates the problem of mass unplanned migration from city to suburb--growth of suburbs at expense of the cities creation of vast metropolitan areas, air pollution, water contamination, and over-crowded highways.

"Conservation, A Job for Young America." Allan Kichel, Jr. McGraw-Hill/ #400285, Film-C/16mm/ 19 minutes, S-$250, R-$15. Litter and what young people can do about it.

Contemporary Films/McGraw-Hill. Special brochure describes the content of 67 films (16mm) "that show what's happening. . .and what can be done now to combat the very serious environmental threats that face us." For rental or purchase.

Denoyer-Geppert Audiovisuals. "Investigations in Ecology," six units each consisting of 60 color sequential captioned slides in Kodak Carousel cartridge, with teacher'a manual; organized to show interrelationship of organisms and their environment, understanding of pollution, overpopulation, extinction of wilderness, decimation of wildlife. On approval purchase offered.

Encyclopaedia Britannica. Special catalog on earth science films, "Our Environmental Crisis," covers some twenty-five 16mm films for junior and senior high school. Films for environmental science "define the problems" of conservation. Three ecology series: "Basic Ecology," "Ecological Processes," "Ecology Communities."

FREE FILMS ON AIR POLLUTION. 1969. Washington, D.C.: U.S. Government Printing Office. $0.15. A listing of HEW films.

"Man, Beast and the Land." NBC. McGraw-Hill/#672535, Film-C/16mm/52 minutes/1&2, S-$610, R-$40. A close look at ecological relationships that dominate the Serengeti-Mara plainlands of East Africa. Realistically simulates safari led by two devoted conservationists, Dr. and Mrs. Lee Talbot.

NBC Educational Enterprises. Collection of 17 color 16mm films on "Man and His Environment" depicts the destruction of man's environment. Sample titles are: "The Ravaged Earth," "Room to Breathe," "Who Killed Lake Erie?," etc. May be rented, previewed, or purchased.

"Our Endangered Wildlife." NBC-TV. McGraw-Hill/#672336, Film-C/16mm/61 minutes/1&2, S-$575, R-$35. Five of seventy-eight species threatened with extinction--key deer, whooping cranes, Kirtland's warbler, timber wolves, bald eagles.

"Pollution is a Matter of Choice." NBC. NBC Educational Enterprises/#0073 C1, Film-C/16mm/53 minutes. S-$497.50, R-$24.40. Modern man has the power to preserve or ruin his environment. What are the priorities? People want what technology gives but are destroyed by its wastes.

"Population Explosion." National Film Board of Canada. McGraw-Hill/#696789, Film-C/16mm/15 minutes. S-$200, R-$12.50. Advances in medical technology are reducing mortality, thereby creating food shortages. Efforts to increase food production in underdeveloped nations are explained.

"Problems of Conservation: Forest and Range." Encyclopaedia Britannica Educational Corporation. Encyclopaedia Britannica Educational Corporation/C#2786, BW #2787, Film C&BW/16mm/16 minutes. S-C-$167.50, BW $86. This film introduces two conservation concepts. It shows how large areas in the U.S. are used as productive forest and range land and illustrates the "multiple-use" programs of protection and management. The dilemma facing modern conservationists is the struggle to retain large undeveloped areas while demands for food, lumber, and recreation for a rapidly expanding population press.

"Problems of Conservation: Wildlife." Encyclopaedia Britannica Educational Corporation. Film-C&BW/16mm, FL. The relationship between living things and the environment. Extinction is a natural process; however, man is the first animal to change the environment so drastically as to cause the wholesale extinction of other species while endangering himself. Man's past and present influence on wildlife conservation practices are described.

"Silent Spring of Rachel Carson." CBS Reports. McGraw-Hill/#408044, Film-BW/16mm/54 minutes/1&2. R-$25. Stimulating--and disturbing--a study of promise and perils of widespread pesticide use.

"The Ecology of Cultivated Areas." Our Living World Series. McGraw-Hill/#613618, Film-C/16mm/16 minutes. S-$215, R-$12.50. Misuse of soil and other resources, grasslands of cultivated areas. Current conservation measures--contour cultivation, strip cropping, terracing, impounding of reservoirs and ponds, classification of land for best use.

"The Food Revolution." CBS. McGraw-Hill/#648003, Film-C/16mm/26 minutes. S-$350, R-$18. Focuses attention on efforts to cope with problem of feeding ever-increasing population: food synthesis techniques, high efficiency farming, the sea as a food source.

"The Garbage Explosion." Encyclopaedia Britannica Educational Corporation. Encyclopaedia Britannica Educational Corporation/C-#2977, BW-#2978, Film-C/BW/16mm/16 minutes. S-C=$200, S-BW=$102.50. A rapidly growing economy is producing equally rapid environmental pollution, with the increase in waste materials. The nature, volume, and composition of solid wastes are discussed. The advantages and disadvantages of current disposal methods are discussed, and long-range solutions are shown.

The Graphic Curriculum, Inc. Catalog of 16mm films on aspects of conservation, ecology, survival, population control, such as: "Search to Survive," "Movements and Migrations," "The Hostile Environment." Produced in cooperation with NET, NSTA, American Library Association, and American Institute of Biological Sciences. Preview prints available.

The Institute for the Study of Science in Human Affairs issued in March 1969 a booklet, A SELECTION OF FILMS FOR THE STUDY OF SCIENCE IN HUMAN AFFAIRS. Order from: The Institute for the Study of Science in Human Affairs, Columbia University, New York, New York 10027.

"The Poisoned Air." CBS-TV. U.S. Department of HEW/#M-1418-X, Film-C/16mm/50 minutes, FL. Spans the world with scenes of air pollution. Interviews with public officials and car manufacturers. City programs are shown, and the importance of citizen action is emphasized.

"The Sense of Wonder and the Edge of the Seal." ABC News. McGraw-Hill/ #656325, Film-C/16mm/30 minutes/1, 21 minutes/2, S-$600, R-$35. A "natural" film in the most liberal sense, from the writings of Rachel Carson.

Time-Life Films. Ten 16mm films produced by BBC-TV, such as: "Torrey Canyon," "The Living Sea," "Science and Foresight." Available for rental or purchase.

"Time of Man." Ealing Corporation. 16mm, 50 minutes. S-$450, R-$40. An extremely informative look at man, his culture, and his position in the environment.

Universal Education and Visual Arts. Applicable topics are contained in over forty 16mm films, six series of filmstrips and overhead transparency sets. Sample titles: "Life on a Mountain," "The Living Tide," and "What Are the Major Causes of Air Pollution." Grades: intermediate to college.

"Urbanissimo." John and Faith Hubley. McGraw-Hill/#408087, Film-C/16mm. S-$90, R-$10. Conservation of America's resources--its land, its wildlife, and its natural beauty.

"We Need Each Other." A group of four 50-minute 16mm films, covering topical ecology problems; with student and teacher aid materials. From the Xerox Corporation.

B. Kits and Records

AIR POLLUTION STUDY PROGRAM. Eduquip, Incorporated, 1220 Adams Street, Boston, Massachusetts 02124. Kits for experiments on detection and analysis.

"America the Beautiful." Gary McFarland: Skye Label. A musical account of its disappearance.

AUDUBON ECOLOGY CHART. National Audubon Society, 1130 Fifth Avenue, New York, New York 10028. $2.15 for maps and charts (33" x 50").

CONSERVATION KIT. American Petroleum Institute, School Program, 1271 Avenue of the Americas, New York, New York 10020. Free pictures and discussion kit, 1970.

EARTH ISLAND. (An Introduction to Ecology in Action.) Educational Division, Department EC, Simon and Schuster, Inc., 1 West 39th Street, New York, New York 10018. A multimedia set of materials to help students understand how we are destroying our environment and what they can do to save the earth from negligence. The kit contains three full-color animated filmstrips by the illustrator Manny Stollman; two 12-inch soundtrack LP records; one

Teacher's Manual; 22 different Eco-Data cards (4 copies of each) with illustrated readings of important ecological issues; four large posters. Also available for $1.25 extra (net $1.00) are student workbooks. Price of the package is $75.00.

"Earth Rot." A musical comment on the state of the environment. David Axelrod: Columbia Records.

ECOLOGY POSTER CARDS. Milton Bradley, Springfield, Massachusetts. $3.00.

ECOLOGY--THE GAME OF MAN AND NATURE. Urban Systems, Incorporated, 1033 Massachusetts Avenue, Cambridge, Massachusetts. 1971. $10.00. While advancing through four ages of development, players try to achieve a balance between man's activities and the natural environment.

"Environmental Overheads." HAMMOND-NEWSWEEK, VISUAL STUDY SERIES. Hammond, Incorporated, Education Division, 515 Valley Street, Maplewood, New Jersey 07040. Various overhead transparencies on urban and world problems of natural resources, environment, and conservation.

ENVIRONMENTAL POSTERS. Environmental Protection Agency, Office of Public Affairs, Rockville, Maryland. Full-color photographs.

EXTINCTION: THE GAME OF ECOLOGY: Sinaver Associates, Incorporated. 20 Second Street, Stamford, Connecticut. $11.95. Examines the key processes by which species survive and evolve or become extinct.

GUIDANCE ASSOCIATES. Pleasantville, New York. Environmental and vocational filmstrips--the most valuable being "The Wisdom of Wildness," by Charles A. Lindbergh.

MAN AND THE ENVIRONMENT. Houghton-Mifflin Company. 1970-71 science catalog for grades 7-12; lists books, films, programs, kits, and overhead transparencies relating to ecological problems. New ecology-based life science course, "Man and the Environment," utilizes games, role playing, and simulation.

PARADISE ISLAND. Simile II, P. O. Box 1023, La Jolla, California 92037. In this population game, students deal with such concepts as incentives for population growth in young nations, population mix, and the need for population control as a society increases its technological base. A sample set is available for $3.00; the complete kit for a class of 18 to 35 students is $25.00.

POLLUTION DETECTION KIT. Oak Ridge Associated Universities, Tennessee, and National Science Foundation. "This Atomic World." c/o Edward Aebischer, Head, Information Services Department, ORAU Incorporated, P. O. Box 117, Oak Ridge, Tennessee.

POSTERS ON POLLUTION. Argus Communications, 3505 North Ashland Avenue, Chicago, Illinois 60657.

PRINCIPLES OF MODERN BIOLOGY. Behavioral Research Laboratories. Nine-volume, complete introduction to ecology/biology in programmed format, self-paced. Produced by Kenneth B. Armitage, Richard W. Holm, and Paul R. Ehrlich. Includes nine corresponding teacher's manuals and the test booklets. Intermediate grades.

SMOG/DIRTY WATER. Strategy games for children or adults @ $10.00. Urban Systems, Incorporated, 1033 Massachusetts Avenue, Cambridge, Massachusetts 02138.

STARPOWER. Simile II, P. O. Box 1023, La Jolla, California 92037. This simulation games deals with the whole question of power structures within a society. It is particularly applicable with regard to industrial pollution and governmental controls over environmental pollution. Sample instructions are available for $3.00; the complete kit for a class of 18 to 35 students is $25.00.

THE BLUE WODJET. Simile II, P. O. Box 1023, La Jolla California 92037. Using this simulation game, students become more aware of the problems pollution control efforts create for industry and of the ways in which citizens and industrial leaders can deal with those problems. Sample sets are available for $3.00; the complete kit for a class of 18 to 25 students is $25.00.

THE ENVIRONMENTAL CHALLENGE OF THE 1970S. Six taped interviews of scientists and politicians. Washington Tapes, Incorporated, 5540 Connecticut Avenue, N.W., Washington, D. C. 20015.

THE POLLUTION GAME. Houghton-Mifflin Company. Students simulate in a game of progressive contamination of our environment then try to reverse the contamination to preserve the environment; students experience the antagonisms and frustrations of trying to change technology and social behavior. Junior and high school level.

VI. ADDITIONAL SOURCES OF ENVIRONMENTAL EDUCATION

Abel, Dana L. 1970. "Environmental Education." Bioscience, 20: 1015-1016.

Abraham, G. K. 1970. "Oversimplification? Pollution Problems." Forecast for Home Economics, 16: F-16.

Adams, U. A. 1970. "Education for Survival." School Management, 14: 10-13.

"Agri-business and Its Potential for Environmental Education." 1971. American Vocational Journal, 46: 24-26.

A LIST OF AVAILABLE CURRICULUM MATERIALS. Environmental Science Center, 5400 Glenwood Avenue, Golden Valley, Minnesota 55422.

Ames, E. A. 1970. "Schools and the Environment." Theory Into Practice, 9: 175-177.

Archibald, David and Paul Gundlack. 1970. "Environmental Education: An Integrated Approach." Environmental Education, 1: 75-76.

"Art, Artists, and Environmental Awareness." Art Education, 23: 53-54.

Arth, A. A. et al. 1970. "Environmental Awareness, the Way of Survival." Educational Leadership, 28: 274-275.

Bailey, Liberty Hyde. 1903. THE NATURE-STUDY IDEA. New York: Doubleday, Page, and Company.

Bain, H. P. 1970. "Education for Survival." Art Education, 23: 14-15.

Balzer, L. 1971. "Environmental Education in the K-12 Span." American Biology Teacher, 33: 220-225.

Bates, M. 1970. "Human Environment." Theory into Practice, 9: 146-149.

BIOLOGICAL SCIENCES CURRICULUM STUDY. University of Colorado, P.O. Box 930, Boulder, Colorado 80302. EARTH SCIENCE CURRICULUM PROJECT. P.O. Box 1559, Boulder, Colorado 80302. The BSCS and ESCP groups are of interest because of their current projects along environmental lines. The BSCS is attempting a joint science-social science studies text; the ESCP is developing an inner city environmental education curriculum. Each group publishes a newsletter available from the address listed above.

Borton, Terry. 1970. REACH, TOUCH AND TEACH: STUDENT CONCERNS AND PROCESS EDUCATION. New York: McGraw-Hill. This is the major publication that has appeared to date from the Affective Development Project.

Brehman, T. R. et al. 1971. "Environmental Activities and Problem Solving." Science Teacher, 38: 55-56.

"Challenge to Art Education." 1970. Art Education, 23: 38-43.

Congressional Quarterly. 1968. EDUCATION IN AMERICA. Washington, D.C.: Congressional Quarterly, Incorporated. $2.95. Covers all aspects and all levels.

Cook, R. S. and George T. O'Hearn. 1971. PROCESS FOR A QUALITY ENVIRONMENT. Green Bay: University of Wisconsin Press. $2.50. Papers presented to the National Conference on Environmental Education.

Damio, W. 1971. "Ecology Bookology." Media and Methods, 7: 26.

Davis, James Garrett. ENVIRONMENTAL PLANNING RECOMMENDATIONS. Environmental Science Center, 5400 Glenwood Avenue, Golden Valley, Minnesota 55422. This is a collection of practical suggestions for the establishment and use of an outdoor environmental study area at the Blake School in Hopkins, Minnesota. The information is valuable for any school interested in the use of the surrounding environment.

Divorky, Diane. Editor. 1969. HOW OLD WILL YOU BE IN 1984? New York: Avon. Student papers on concepts of the school environment.

Durrenberger, Robert W. 1970. ENVIRONMENT AND MAN/A BIBLIOGRAPHY. Palo Alto, California: National Press Books. $2.50.

Dwyer, R. L. 1971. "School Camping Programs: Ecology in the Outdoor Classroom." Social Education, 35: 74-77.

"Ecological Programs in Vocational Education." 1971. American Vocational Journal, 46: 20-26.

EDUCATION PRODUCT REPORT. 1971. Environmental Education Materials, Washington, D.C. Volume 4, Numbers 6 and 7. March-April. A bibliography of selected materials.

Engleson, D. E. 1970. "Status of Conservation Courses in Wisconsin High Schools." Science Teacher, 37: 33-35.

"Environmental Citizenship: Where to Begin?" Art Education, 23: 33-35.

ENVIRONMENTAL EDUCATION: EDUCATION THAT CANNOT WAIT. 1970. Washington, D.C.: U.S. Government Printing Office. $0.30. A valuable definition and rationale of environmental education.

ENVIRONMENTAL EDUCATION FOR EVERYONE--A BIBLIOGRAPHY OF CURRICULUM MATERIALS FOR ENVIRONMENTAL STUDIES. Washington, D.C.: NEA Publication Sales. Stock Number 471-14600. $0.75.

"Environmental-Related Research in Agricultural Education." 1971. Agricultural Education, 43: 229-230.

"Environmental Science Education in Ohio." 1971. Agricultural Education, 43: 244-246.

ENVIRONMENT AND THE SCHOOLS. 1971. Washington, D.C.: National Schools Public Relations Association. $4.00.

Entorf, J. F. 1971. "Becoming Aware of Waste: Teaching Unit on Recycling." School Shop, 30: 78-79.

Evans, B. 1971. "Traditional Conservation Education Is Inadequate." Compact, 5: 18-20.

Fleck, H. 1970. "Facing the Environmental Crisis." Forecast for Home Economics, 16: F-9.

Fong, M. K. 1971. "Survival Training." Compact, 5: 31-33.

Fuller, D. M. 1970. "Junk Environment Project." Art Education, 23: 16-33.

Glass, B. 1971. "Human Multitude: How Many Is Enough?" American Biology Teacher, 33: 265-269.

Glenn, H. T. 1971. "Learn and Teach the New Pollution-Control Methodology." School Shop, 30: 71-73.

Grubough, R. et al. 1971. "Environmental Management and Vocational Agriculture." Agricultural Education, 43: 222.

Gustafson, J. A. 1969. "Conservation Education, Today and Tomorrow." Science Education, 53: 187-190.

Hammon, S. 1970. "Sound Polluted Schools." School Management, 14: 14-15.

Hardy, C. A. 1971. "Environmental Education: An Action Proposal." Contemporary Education, 42: 276-279.

Harlin, U. K. 1971. "Health Scientist Views Environmental Problems." Journal of School Health, 41: 48-51.

Hebert, R. 1971. "Ecology: A Shared Journey." Personnel and Guidance Journal, 49: 737-739.

Hill, W. 1970. "Relating Geography to Environmental Education." Journal of Geography, 69: 485-487.

Howarth, C., Jr. 1970. "Challenge to Environmental Education." Art Education, 23: 36-37.

"Industrial Education and the Environment." 1971. School Shop, 30: 63-91.

INTERACTION OF MAN AND THE BIOSPHERE. Chicago: Rand McNally. This is a junior high life science text developed to accompany MATTER AND ENERGY.

Kormondy, E. J. 1971. "Environmental Education: The Whole Man Revisited." American Biology Teacher, 33: 15-17.

Krall, R. 1970. "Mudhole Ecology." American Biology Teacher, 32: 351-353.

Krupsky, C. H. 1971. "Stop Our Pollution: Projects and Activities." School and Community, 57: 32.

"Laboratory School and Field Campus Used in a Biology Methods Course." 1970. American Biology Teacher, 32: 537-543.

"Lack of Material, Jealousy Hamper Environmental Courses." 1971. Educational Product Report, 4: 5.

Lanier, V. 1970. "Ecology: Cop-out or Foul-up." Arts and Activities, 68: 46-48.

Maley, D. 1971. "Environmental Education: Solving the Problems." Man/Science/-Technology, 30: 146-148.

MAN: A COURSE OF STUDY. Education Development Center, 15 Mifflin Place, Cambridge, Massachusetts 02138. An elementary course following a format that would be of value at any level. The lives of salmon, herring gulls, baboons, and Eskimos are studied with the aim of answering the question, "What is human about man?"

Manson, G. A. et al. 1970. "Perspectives on Man and His Environment." Journal of Geography, 69: 279-283.

MAN THE MEANING MAKER. Boston, Massachusetts: Beacon Press. This is an elementary curricular package that could be put to use at any grade level. The verbal environment is studied objectively, raising questions of how our perceptions are colored by our capabilities of communication and expression.

Marland, S. P., Jr. 1971. "Environmental Education Cannot Wait." American Education, 7: 6-10.

"Mathematics Educators Must Help Face the Environmental Pollution Challenge." 1970. Math Teacher, 64: 33-36.

McCammon, L. C. 1970. "Man's Greatest Challenge, the Quest for Environmental Quality." Journal of School Health, 40: 284-289.

McDonald, Rita. 1970. GUIDE TO LITERATURE ON ENVIRONMENTAL SCIENCES. Washington, D.C.: American Society for Engineering Education.

McGowan, A. 1971. "Experiment in Environmental Education." Physics Teacher, 9: 141-144.

Meadows, B. J. 1970. "Denver School Dramatizes Population-Pollution." American Biology Teacher, 32: 281-283.

Mings, R. C. 1971. "Some Suggestions for Reorienting Conservation Education." Social Studies, 62: 160-163.

MINNESOTA STATE PUBLICATIONS CATALOG. St. Paul Minnesota: Minnesota State Publications. Free. Includes environmental education curriculum material.

Moore, J. A. 1971. SCIENCE FOR SOCIETY: A BIBLIOGRAPHY. Washington, D.C.: AAAS Publication.

Murphy, J. 1970. "Exercise in Winter Ecology." Science Teacher, 37: 59-61.

Needam, D. 1970. "Pollution Is a Teaching and Action Program." Grade Teacher, 88: 24-33.

Norton, T. W. 1971. "Atmosphere as a Science Classroom Resource." Physics Teacher, 9: 265-267.

Overcash, J. R. 1971. "Environmental Study in the City--Boston." Science Teacher, 38: 18-20.

Peddiwell, J. Abner. 1939. SABER-TOOTH CURRICULUM. New York: McGraw-Hill. Peddiwell's work is a classic study of the problems of meeting environment with curriculum and vice versa. It is as valuable now as it was when first published.

PEOPLE AND THEIR ENVIRONMENT. Columbia, South Carolina: J. C. Ferguson Publishing Company. This is a set of teacher guides raising environmental questions for classes K-12. At the secondary level, the workbooks also branch out into subject areas such as life science, social studies, and home economics. Conservation Curriculum Improvement Project, South Carolina Department of Education.

Pratt, A. L. Editor. 1971. ENVIRONMENTAL EDUCATION IN THE COMMUNITY COLLEGE. Washington, D.C.: American Association of Junior Colleges. $4.00. A collection of articles with special reference to careers.

PROGRAMS IN ENVIRONMENTAL EDUCATION. (Stock Number 471-14394.) The National Science Teachers Association, Washington, D.C.: NEA Publication Sales. $1.50.

Ritter, Paul. 1966. EDUCREATION: EDUCATION FOR CREATION, GROWTH, AND CHANGE. Oxford: Pergamon Press.

Roberts, A. D. et al. 1971. "Environmental Education." Clearing House, 45: 451-455.

Rogers, L. 1971. "Conservation 70's: A Concept for Environmental Action." Science Education, 55: 57-60.

Rosenthal, R. and L. F. Jacobson. 1968. "Teacher Expectations for the Disadvantaged Child." Scientific American, April: 19-23.

Roth, R. 1970. "Environmental Management Education: Where from Here?" Theory into Practice, 9: 187-190.

Roth, Robert E. 1970. "Fundamental Concepts for Environmental Management Education (K-16). Environmental Education, 1: 65-75.

Rumpf, E. L. 1971. "Ecological Challenge: Response at the National Level: USOE Takes First Steps." American Vocational Journal, 46: 20-21.

Sager, M. C. 1971. "Ecological Balance of the Planet Earth." Social Education, 35: 47-52.

Scherff, G. E. 1971. "Exploring Industrial Pollution Control." School Shop, 30: 77.

Schrank, J. J. 1970. "What Good Are Pelicans? A Guide to Teaching Materials in Ecology." Media and Methods, 6: 32-37.

Sehgal, P. P. 1970. "Basis for Action in the Environmental Crisis." American Biology Teacher, 32: 480-483.

Smalley, L. 1970. "Is Industrial Arts Relevant without Talking about Pollution Control?" Industrial Arts and Vocational Education, 59: 38.

Smith, A. and C. M. Smith. 1970. "Aesthetics and Environmental Education." Journal of Aesthetic Education, 4: 125-140.

SOCIAL EDUCATION. The entire January 1971 issue is devoted to environmental education.

Sonnenfeld, J. 1970. "Geopolitical Environment as a Perceptual Environment." Journal of Geography, 69: 415-419.

Spolin, Viola. 1963. IMPROVISATION FOR THE THEATRE. Evanston, Illinois: Northwestern University Press. Innovative teaching techniques, including games, all pointed toward communication and environmental awareness.

Stokes, R. L. 1971. "Art Education Fights Pollution." School and Community, 57: 26.

Stotler, D. 1971. "Environmental Education as Liberation." American Biology Teacher, 33: 18-21. A fine article.

"Students Trained for Employment in National Resource Management." 1971. American Vocational Journal, 46: 32.

Swan, James. 1969. "The Challenge of Environmental Education." Journal of Phi Delta Kappa, 51: 26-28.

Swan, Malcolm D. Editor. 1970. TIPS AND TRICKS IN OUTDOOR EDUCATION. Danville, Illinois: Interstate Printers and Publishers. This is generally more useful than its title implies. Though modest in format, it is probably the best handbook of specifically environmental teaching techniques available.

Tanner, R. P. 1971. "Future: Alternatives for Man's Environment." Man/Science/-Technology, 30: 149-151.

"Teachers and Students Write a Curriculum on Water Pollution." American Biology Teacher, 33: 211-213.

"Teaching for Consumer Conscience in Business Education." American Vocational Journal, 46: 22-23.

Terry, Mark. 1971. TEACHING FOR SURVIVAL. New York: Ballantine. $1.25. Excellent.

THE QUEST FOR ENVIRONMENTAL QUALITY. 1971. Washington, D.C.: U.S. Government Printing Office. $0.35. An annotated bibliography of federal and state action.

"Toward a More Humane Environment: A Symposium." Theory into Practice, 9: 145-202.

"Toward Real Public Involvement in Environmental Decision Making." Art Education, 23: 30-32.

Trohanis, P. 1971. "Environmental-Ecological Education via Simultaneously Projected Multiple Images with Sound." Audio-Visual Instruction, 16: 19-26.

"Update: Environmental Studies--Critical Reviews of Two Major Curricula." 1971. Education Product Report, 4: 35-47.

U.S. Department of Agriculture. 1964. TEACHING SOIL AND WATER CONSERVATION. Washington, D.C.: U.S. Government Printing Office.

Viran, V. E. et al. 1971. "Environmental Education--Information, Ideas, and Activities." The Instructor, 80: 51-62.

Von Dommelen, D. B. 1970. "Interior Design and the Environmental Designer." Journal of Home Economics, 62: 342-343.

"What Schools Can Do About Pollution: A Symposium." Today's Education, 59: 14-29.

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VII. FEDERAL AGENCIES AND STATUTES

A. Texts

Bureau of National Affairs. ENVIRONMENTAL REPORTER. Washington, D.C.: The Bureau of National Affairs, 1231 25th Street, N.W. $340 a year. Published weekly. Comprehensive source of laws, cases, new developments, existing programs and agencies.

California Legislature (Assembly). 1970. ENVIRONMENTAL BILL OF RIGHTS. Sacramento: Select Committee on Environmental Quality. The report lists the major reasons for environmental degradation, identifies the key policy issues, and lays out an orderly process for assessing man's future activities in order to assure environmental protection and prevent environmental crises.

Cooley, Richard A. and Geoffrey Wandesforde-Smith. Editors. 1970. CONGRESS AND THE ENVIRONMENT. Seattle: University of Washington Press. A collection of case studies of important environmental legislation, tracing its formation and effects.

Degler, Stanley E. 1970. STATE AIR POLLUTION CONTROL LAWS. Washington, D. C.: Bureau of National Affairs. A summary of the status of the law on air pollution control in each state, the District of Columbia, Puerto Rico, and cities of Chicago, Detroit, New York, Philadelphia, and Pittsburgh. Contains administering agency description, regulations in each state, and state air pollution control law.

Lear, J. Editor. 1968. "Science, Technology, and the Law." Saturday Review, August 3.

Lewin, S. F., A. H. Gordon, and L. J. Hartelius. 1970. LAW AND THE MUNICIPAL ECOLOGY, AIR, WATER, NOISE, OVERPOPULATION. Washington, D. C.: National Institute of Municipal Law Office.

Sherrod, H. F. 1970. ENVIRONMENTAL LAW REVIEW. New York: Clark Boardman Company.

U.S. House of Representatives. 1970. LAWS OF THE UNITED STATES RELATING TO WATER POLLUTION CONTROL AND ENVIRONMENTAL QUALITY. (Committee on Public Works.) Washington, D. C.: U.S. Government Printing Office. $1.00.

U.S. Senate. 1970. ENVIRONMENTAL PROTECTION ACT OF 1970. (Hearings Before the Subcommittee on Energy, Natural Resources and Environment. 91st Congress. Second Session.) Washington, D. C.: U.S. Government Printing Office.

U.S. Senate. 1970. HOW CAN OUR PHYSICAL ENVIRONMENT BEST BE CONTROLLED AND DEVELOPED? (Pursuant to Public Law 88-246. 91st Congress. Second Session.) Washington, D. C.: U.S. Government Printing Office. $1.00.

B. Federal Statutes

[AIR -- NO TITLE]. 1955. (P.L. 84-159.)
This act established grants to states and educational institutions to train personnel and conduct research and control on air pollution.

AIRCRAFT NOISE ABATEMENT ACT. 1968. (P.L. 90-411.)
This act, an amendment to the Federal Aviation Act, provides for standards of measurement and control of aircraft noise and sonic booms.

AIR QUALITY ACT. 1967. (P.L. 90-148.)
This act gave power to each state to set standards for primary and secondary ambient air quality standards, provided, however, that they were approved by the Secretary of HEW. It further provided for the establishment of air quality control regions, registration of fuel additives, a larger research program, vehicle inspection, and power to HEW to seek a court injunction against any air pollutor if an emergency exists.

ATOMIC ENERGY ACT. 1946.
This act established the Atomic Energy Commission, which took over the military nuclear program from the Manhattan Engineer District of the U.S. Army. The AEC today operates 12 programs for both civilian and military use, which include among others a weapons program, a biology and medicine program, a research program, and a reactor development program. The AEC is charged with both the development of military and peaceful uses of atomic energy, and with regulating the nuclear industry to assure that public health and safety are protected.

CLEAN AIR ACT. 1963. (P.L. 88-206.)
This act increases grants to states and institutions for research and authorizes the Federal government to take action to abate interstate air pollution.

CLEAN AIR AMENDMENTS. 1970. (P.L. 91-604.)
An omnibus amendment to the 1967 Clean Air Act, authorized national quality air control standards, with Federal enforcement of standards. It also made specific demands on automobile manufacturers for better emission control devices; aircraft, air, and noise pollution controls were also enforced.

CLEAN WATER RESTORATION ACT. 1966. (P.L. 89-753.)
This law transfered the FWPCA to the Interior Department and provided for greatly increased grants to construct advanced waste water treatment facilities.

ENDANGERED SPECIES CONSERVATION ACT. 1969. (P.L. 91-135.)
This law instructs the Bureau of Sport Fisheries and Wildlife to compile data on near-extinct wildlife, to plan and to provide technical assistance, and to carry out programs designed to protect and conserve fish and wildlife.

ENVIRONMENTAL EDUCATION ACT. 1970. (P.L. 91-516.)
This act funds various programs under the U.S. Office of Education. Included are: environmental education curriculum development, demonstration, evaluation, and dissemination; teacher training; elementary, secondary, and community education program initiation and maintenance; research grants; technical assistance; planning outdoor ecological study centers; and preparation of environmental and ecological materials suitable for use by the mass media. Environmental education is concerned with man's total relationship with his natural and manmade environment and includes the relation of population, pollution, resource management, conservation, transportation, technology, and urban and rural planning.

ENVIRONMENTAL QUALITY IMPROVEMENT ACT. 1970. (P.L. 91-224.)
Established the Office of Environmental Quality to assist Federal agencies to coordinate environmental programs and develop interrelated Federal criteria.

FEDERAL OIL POLLUTION ACT. 1924. (33USC 431.)
This law prohibited oil pollution from ocean-going vessels; however, enforcement under this law was cumbersome and ineffective.

FISH AND WILDLIFE COORDINATION ACT. 1958. (P.L. 85-624.)
This act empowers the Federal government to provide assistance to, and cooperation with, all public and private agencies in the development, protection, rearing and stocking of all species of wildlife; to conduct surveys and investigations of all wildlife in the public domain; and to require that any action which may alter land or water or endanger any and all fish and game must receive prior permission from the U.S. Fish and Wildlife Service.

INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT. 1947. Amendments to 1964.
This act prohibited the marketing and transfer of any poison or device without proper registration and approval of the U.S. Public Health Service.

MOTOR VEHICLE AIR POLLUTION CONTROL ACT. 1965. (P.L. 89-272.)
This act gave the Secretary of HEW the authority to establish regulations controlling emissions from all new motor vehicles.

NATIONAL ENVIRONMENTAL POLICY ACT. 1969. (P.L. 91-190.)
It pledged the Federal government to "identify and develop methods and procedures . . . which will insure that presently unqualified environmental amenities and values may be given appropriate consideration in decision-making . . ."

NATIONAL MATERIALS POLICY ACT. 1970. (P. L. 91-512.)
This law establishes a committee to study the supply, the use, the recovery and disposal of natural resources by industry for the production of goods exclusive of food.

NATIONAL TRAILS SYSTEM ACT. 1968. (P. L. 90-543.)
This act calls for studies of historic national trails and creation of both historic and wilderness trails.

RECLAMATION ACT. 1902.
This law authorized the Secretary of the Interior to locate, construct, operate, and maintain works for the storage, diversion, and development of waters for the reclamation of arid and semi-arid lands.

RESOURCE RECOVERY ACT. 1970. (P. L. 91-512.)
(An omnibus amendment of the Solid Waste Disposal Act of 1965.) It provided grants to States, interstate agencies, and localities for the establishment of solid waste disposal facilities, provided funds for the training of personnel in this field, and set regulations for solid waste recovery, collection, and disposal.

RIVERS AND HARBORS ACT. 1899. (33USC 401-413.)
This law prohibited the dumping of pollution and debris into navigable waters or the construction of bridges, wharves, dams, etc. without Federal permission. It was originally designed to prevent impediments to navigation. It has lately been used as an antipollution measure.

SOLID WASTE DISPOSAL ACT. 1965. (P. L. 89-272.)
This act provides research and training grants for states to establish solid waste recycling and disposal plants, guidelines for system development, technical assistance to states, local governments, and interstate agencies for planning new systems and funds to the same for demonstration, construction, and application of solid waste systems.

[WATER -- NO TITLE]. 1961. (P. L. 87-88.)
This law provided increased grants for waste treatment plant construction, monies for research in water pollution control, and established seven field laboratories.

WATER POLLUTION CONTROL ACT. 1948. (P. L. 80-845.)
This act established the authority of the Federal Government to have a role in controlling interstate water pollution (although subordinate to the States). The act also provided for construction loans, although they were never funded.

WATER POLLUTION CONTROL ACT AMENDMENTS. 1956. (P. L. 84-660.)
These amendments gave permanent water pollution control authority to the Federal government, authorized court action to halt interstate water pollution, and provided for grants to construct waste water treatment programs.

WATER QUALITY ACT. 1965. (P. L. 89-234.)
This law created the Federal Water Pollution Control Administration within HEW, set water quality standards for Federal and State regulation, greatly streamlined enforcement procedures, and provided for project grants for research and development on combined sewers.

WATER QUALITY IMPROVEMENT ACT. 1970. (P. L. 91-224.)
It established Federal procedures relating to oil spills' pollution along the coastal areas and set stiff penalties for willful pollution. It further provided for more strict marine sanitation devices, training for waste treatment personnel, and for demonstration grants for water treatment in lakes and mine areas.

WATER RESOURCES PLANNING ACT. 1965. (P. L. 89-80.)
This act provides for the development of the nation's water resources, establishes a Water Resources Council and River Basin Commissions, and funds state water planning programs.

WATER RESOURCES RESEARCH ACT. 1964. (P. L. 88-379.) 1966. (P. L. 89-404.)
These acts established water research centers, promoted a national program of water research, and trained water scientists.

WATERSHED PROTECTION AND FLOOD PREVENTION ACT. 1954.
This law requires that the U.S. Forest Service and the Soil Conservation Service cooperate with all involved public and private agencies in planning and installing forestry and land resource measures in the watershed to protect against floods and fires.

WILD AND SCENIC RIVERS ACT. 1968. (P. L. 90-542.)
This law required that studies be made jointly by the Departments of Interior and Agriculture to permanently preserve stated rivers in their natural state and to conduct special studies on certain named rivers before any construction or alteration would be allowed on them.

WILDERNESS ACT. 1964. (P. L. 88-577.)
This act directs the Secretary of Interior to review every roadless area or island within the National Wildlife and Refuge System of 5000 acres or more and make recommendations to the President to maintain these areas as wilderness in their natural and primitive state.

The above listing comprises only partially the Federal laws which have an impact on the environment. Realistically, every bill entered into law has environmental implications. Only the major laws were listed; however, the following are additional laws which may be of environmental interest:

FEDERAL AID TO HIGHWAYS ACT. 1958.

FEDERAL AVIATION ACT. 1958.
FEDERAL POWER ACT.
FLOOD CONTROL ACT. 1950.
FOOD, DRUG, AND COSMETIC ACT. 1964.
GENERAL MINING ACT. 1872.
HIGHWAY BEAUTIFICATION ACT. 1965.
HOMESTEAD ACT. 1862.
MINERAL LEASING ACT. 1920.
MINING CLAIMS, RIGHTS, AND RESTORATION ACT. 1955.
MULTIPLE-USE SUBSTAINED YIELD ACT.
NATIONAL AERONAUTICS AND SPACE ACT. 1958.
NATIONAL PARKS ACT.
NATIONAL WATER COMMISSION ACT. 1968.
NEW YORK HARBOR ACT.
OUTER CONTINENTAL SHELF ACT.
POPULATION GROWTH AND AMERICAN FUTURE ACT. 1970.
SMITHSONIAN INSTITUTION ACT. 1846.
SUBMERGED LANDS ACT.
WATER PROJECT RECREATION ACT. 1965.
WETLANDS ACT.

C. Federal Agencies

Department of Agriculture
  Agricultural Research Service, Agricultural Stabilization and Conservation Service, Cooperative State Research Service, Economic Research Service, Farmers Home Administration, Forest Service, Soil Conservation Service.

Appalachian Regional Commission

Atomic Energy Commission

Department of Commerce
  Economic Development Administration, Environmental Science Services Administration, National Bureau of Standards

Delaware River Basin Commission

Department of Defense
  Army Corps of Engineers

Environmental Protection Agency

Executive Office of the President
  Council on Environmental Quality, Office of Science and Technology

Federal Power Commission

Department of Health, Education, and Welfare
    Environmental Health Service, Environmental Control Administration, Food and Drug Administration, National Institutes of Health, Office of Education

Department of Housing and Urban Development

Department of the Interior
    Bonneville Power Administration, Office of Coal Research, Bureau of Sport Fisheries and Wildlife, U.S. Geological Survey, Bureau of Indian Affairs, Bureau of Land Management, Bureau of Mines, National Park Service, Bureau of Outdoor Recreation, Bureau of Reclamation, Office of Saline Water, Office of Water Resources Research

International Boundary and Water Commission, United States and Mexico

International Joint Commission, United States and Canada

Department of Justice

National Aeronautics and Space Administration

National Science Foundation

National Water Commission

Commission on Population Growth and the American Future

Smithsonian Institution

Department of State

Tennessee Valley Authority

Department of Transportation
    U.S. Coast Guard, Federal Aviation Administration

Water Resources Council

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